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Argonne National Lab., IL

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The purpose of this study is to provide guidance on the technical and economic feasibility of an integrated utility system that would use coal and solid waste as fuels for producing steam and electricity for all of the needs of the University of Florida. The report includes the technologies of the existing system, a coal reference system, a coal cogeneration system, and an integrated utility system along with the economics of first year operation.

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Technical assistance by personnel teams. 42 USC 6913

RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

UNIVERSITY OF FLORIDA

INTEGRATED UTILITY SYSTEM

CONCEPTUAL FEASIBILITY ANALYSIS AND ASSESSMENT

Prepared by:
Argonne National Laboratory
and
DSI Resource Systems Group, Inc.

Prepared for:
U. S. Department of Energy
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CHAPTER 1

EXECUTIVE SUMMARY

The Integrated Utility System (IUS) under consideration by the University of Florida represents a timely response to the increasingly pressing problems caused by the nation's dependence on oil and natural gas. The IUS would permit a switch from oil and gas to coal and solid waste as fuels for producing all the steam and most of the electricity needed by the campus. Upwards of 373,000 barrels of fuel oil (equivalent) of scarce fossil fuels could be saved each year. In addition to the benefits of scarce fuel conservation, the IUS can be expected to result in a net savings in the cost of satisfying the University's energy needs.

These energy and cost benefits will occur because an IUS would make more efficient use of two energy resources than does the existing University energy system. Waste heat from electricity production would be used to satisfy campus space heating requirements and most of the space cooling needs. Campus and Gainesville/Alachua County solid waste would be utilized as a source of energy for steam production. The existing system produces low pressure steam and very little electricity. The majority of the University's electricity is purchased from outside sources. Hence, large quantities of low quality heat which could be used for space conditioning in an IUS is instead being wasted at the remote utility. Furthermore, no use is made of the energy content of either the University's or the City and County's solid waste.

The purpose of this study is to provide guidance on the technical and economic feasibility of the University of Florida IUS. The evaluated IUS incorporates approaches to resource conservation which the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) are evaluating in other community settings across the country. Experience gained through DOE's Integrated Community Energy Systems (ICES) program, and through various EPA and DOE resource recovery programs, indicates that under the proper conditions an IUS-type project: (a) is beneficial from resource conservation, environmental, and economic points-of-view; (b) is technically feasible; and (c) is implementable by a public agency. The University has asked DOE and EPA to analyze whether or not the conditions leading toward a successful project are present in this case.

A previous study* cosponsored by the National Bureau of Standards and the Department of Health, Education, and Welfare, reported favorably on the feasibility of an IUS at the University, and developed considerable information relating to a conceptual design. Several conditions have changed since the study was completed, including the cost of capital equipment and energy. Thus, the most important aspect of the effort summarized here was to assess whether or not the University's IUS concept continues to appear to be technically and economically feasible. The results and data in the Reynolds, Smith & Hills study were used as the foundation for the present assessment. This was critical in order to perform this assessment under the time limits imposed.

The time constraint made it necessary to confine the scope of the investigation to a single approach to an IUS and to make some simplifying assumptions during the analysis. Consequently, the results presented in this report are indicators of the quality of the IUS as an opportunity for public investment.

The University of Florida Integrated Utility System

Currently, the University meets all of its steam needs and only five percent of its electricity requirements with gas and oil burned in its power plant. The remaining electricity is purchased from Florida Power Corporation. The steam is ultimately used for space heating; space cooling is accomplished with electric and steam driven centrifugal chillers. The condition of the existing steam plant at the University indicates a need to install another new boiler within the next few years. University building plans suggest that a new 120,000 lb/hr boiler will be installed. Federal regulations will prohibit the construction of Major Fuel Burning Installations (MFBI's) designed to burn oil or natural gas as primary fuels. The new boiler at the University will fall well within the federal definition of an MFBI. Although an exemption can be applied for, it is unlikely that the University will be allowed to construct a new oil-fired boiler; any new facility will have to burn coal or some other fuel which is less scarce than gas and oil.

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* Integrated Utility Systems: Feasibility Study and Conceptual Design at the University of Florida; Reynolds, Smith & Hills (under contract No. HEW-100-75-0181 for the U. S. Department of Health, Education, and Welfare); October, 1976.

The heart of the IUS concept is the use of new coal-fired spreader stoker-equipped boilers to generate moderate pressure and temperature steam for power production in backpressure turbines. Low pressure steam leaving the turbine would be used to satisfy all the University's space heating needs and much of the cooling requirements. Cooling is accomplished with new absorption chillers that use low-pressure extraction steam to generate cold water. Variable capacity regenerative heaters facilitate load matching by using exhaust steam which may not be needed by either the absorption chillers or for the University's space heating requirements. Such capability will help minimize electrical demand. It is estimated that this cogeneration approach to simultaneous steam and electricity production will result in the University being able to continue to self-satisfy all of its steam requirements and at the same time provide for over 90 percent of its electricity requirements. Thus, the IUS comes close to being a total energy system. Oil and gas consumption to meet the University's energy needs would, therefore, be reduced to a negligible amount.

In addition to the cogeneration system, the IUS conceptual design incorporates solid waste-derived fuel. The University's solid waste would be burned in a starved-air combustion unit which produces hot combustible gases. These gases are then introduced into the boilers to generate steam. Solid waste from the Gainesville/Alachua County area would be processed off-site to produce densified refuse-derived fuel (dRDF) --a solid fuel made up primarily of the paper and plastics in the incoming waste. The conceptual design of the IUS, and particularly of the boilers, accommodates the use of dRDF as a coal substitute. Thus, both solid waste subsystems result in coal being replaced by a relatively replenishable fuel. In addition, the amount of the Gainesville/Alachua County area's solid waste which must be landfilled is significantly reduced.

Figure 1 depicts the IUS concept and diagramatically shows the interrelationship of its elements. The Gainesville/Alachua County solid waste subsystem is also designed to recover magnetics from the waste; further material recovery processes could be added as market conditions warrant.

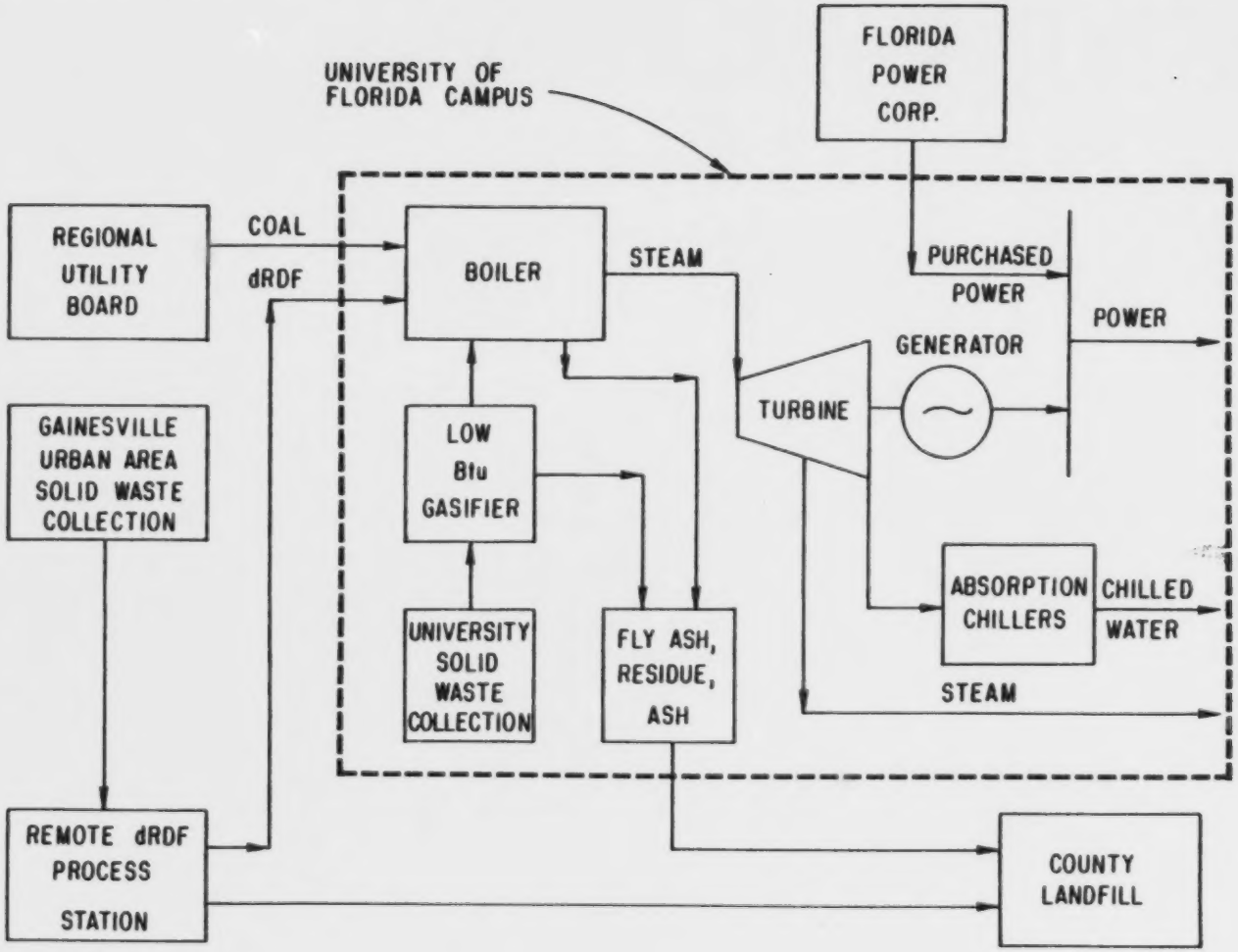


FIGURE 1

DIAGRAMMATIC FLOW CHART

OF THE UNIVERSITY OF FLORIDA IUS

Energy Consequences of the IUS

The IUS has two energy consequences. First, the total amount of raw fuel energy input required to meet the University's needs is reduced. More importantly, the mix of fuels to meet these needs is altered dramatically from a dependence on scarce and non-replenishable fuels to consumption of relatively abundant (coal) and replenishable (solid waste) fuels. For the purpose of assessing the energy impact of the IUS, three cases have been compared to the existing system.

CASE I represents a COAL REFERENCE SYSTEM which is exactly the same design as the existing system except that outdated equipment is replaced with a 120,000 lb/hr coal-fired boiler. (This case conforms with the most likely federal requirements regarding prohibitions of oil and gas as boiler fuels).

CASE II represents the installation of a 300,000 lb/hr COAL COGENERATION SYSTEM (i.e., the heart of the evaluated IUS without the solid waste subsystems) to replace all of the existing boiler capacity.

CASE III represents the analyzed IUS, with a coal/solid waste cogeneration system.

Energy balances confirm that the coal cogeneration system and the evaluated IUS result in substantially less consumption of scarce fuels (e.g., oil and gas). In the case of the IUS, this consumption is shifted to coal and solid waste. In the cogeneration system, the shift is to coal only. Furthermore, the IUS reduces the consumption of nonreplenishable fuels by over 20 percent. Figure 2 illustrates the energy consumption and fuel mix characteristics of each of the cases.

Environmental Consequences of the IUS

On balance, it is unlikely that the IUS would cause an adverse net environmental impact compared to the existing system. All current environmental regulations should be able to be met through sound design and construction practices. The significant reduction of solid waste for land disposal could result in an environmental benefit.

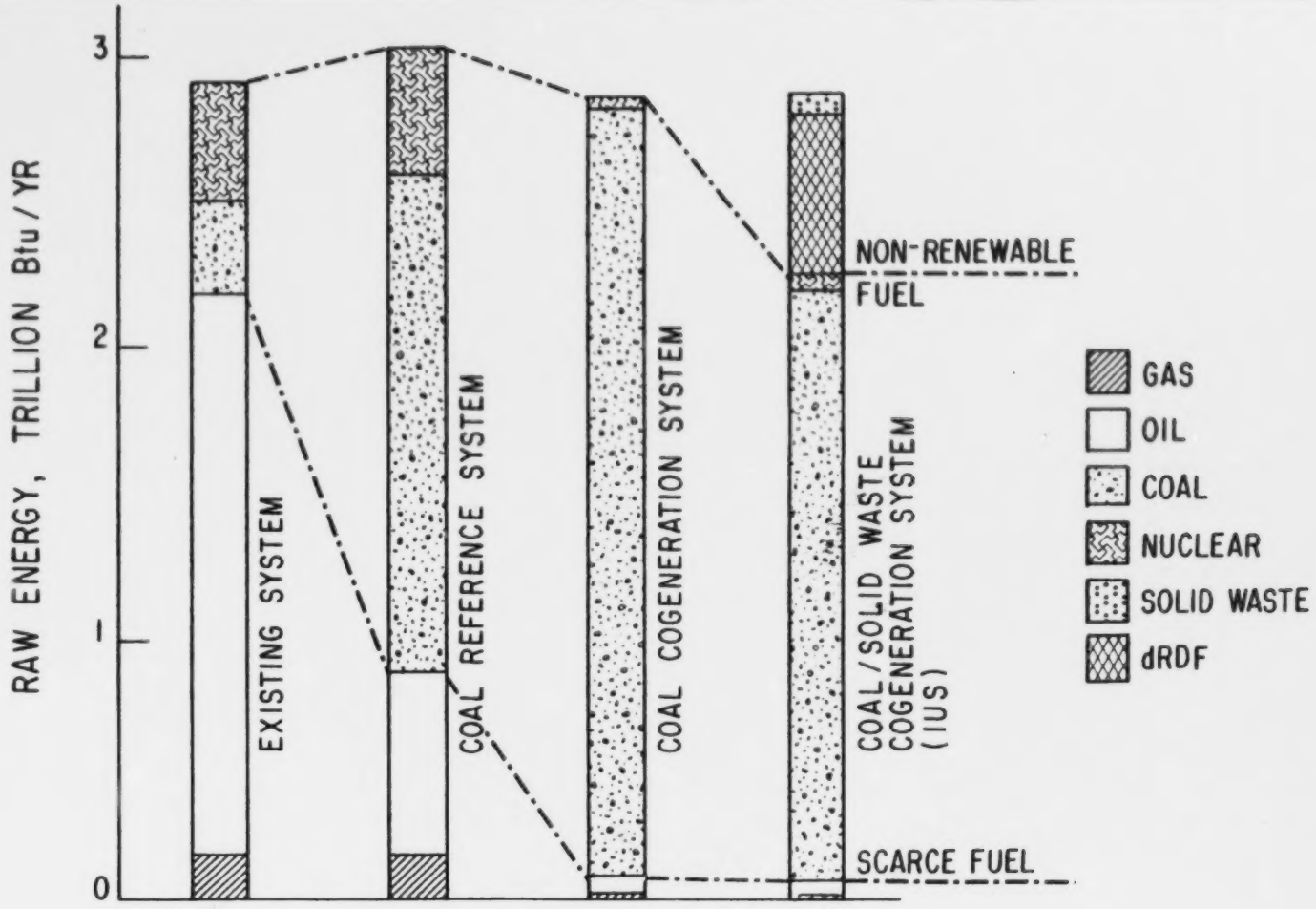


FIGURE 2

TOTAL RAW ENERGY USED TO SUPPORT
UNIVERSITY OF FLORIDA ENERGY NEEDS
INCLUDING PURCHASED POWER FROM F.P.C.

Economics of the IUS

It is estimated that the plan to replace out-dated equipment with a new 120,000 lb/hr boiler will result in a capital expenditure of over $20 million. This amount is for a coal-fired boiler. The IUS would require an additional investment of approximately $28 million, of which about $8 million is for the two solid waste subsystems. This additional investment for the IUS results in savings of $2.9 million in the first year of operations. These savings can be expected to increase over time.

The estimated pay-back period for the incremental investment on the IUS is 10 years. This corresponds to an interest rate of return of 15 percent.

Table 1 presents a comparison of the economics of the three cases. Because the estimates contained in the table are based on budget cost estimates considerable conservatism has been applied in the assumptions underlying the estimates. Some of this conservatism might be liberalized once better information is available.

The most conservative assumption applied was that the University's energy needs and mix would not change significantly in future years. Were electrical and steam needs to grow dramatically, the market forces would be expected to cause the IUS to save more cost and scarce fuels.

Implementing the IUS

Implementation of the IUS could occur in four distinct phases:

- Planning, System Selection and Preliminary Design
- Procurement
- Final Design and Construction
- Commercial Operations

Because the cost for delays in implementing the IUS project approaches $5 million per year, it is vitally important to the IUS project that an organization and individual be assigned the responsibility to manage the project and orchestrate the available resources. Equally important is a clear definition of the project decision-making process and the initiation of a process for involving the several project participants in the implementation process.

Rough estimates of the time required to complete each phase are shown in Figure 3, along with a representative profile of pre-commercial

TABLE 1.

FIRST YEAR ECONOMICS JULY 1982 – JULY 1983

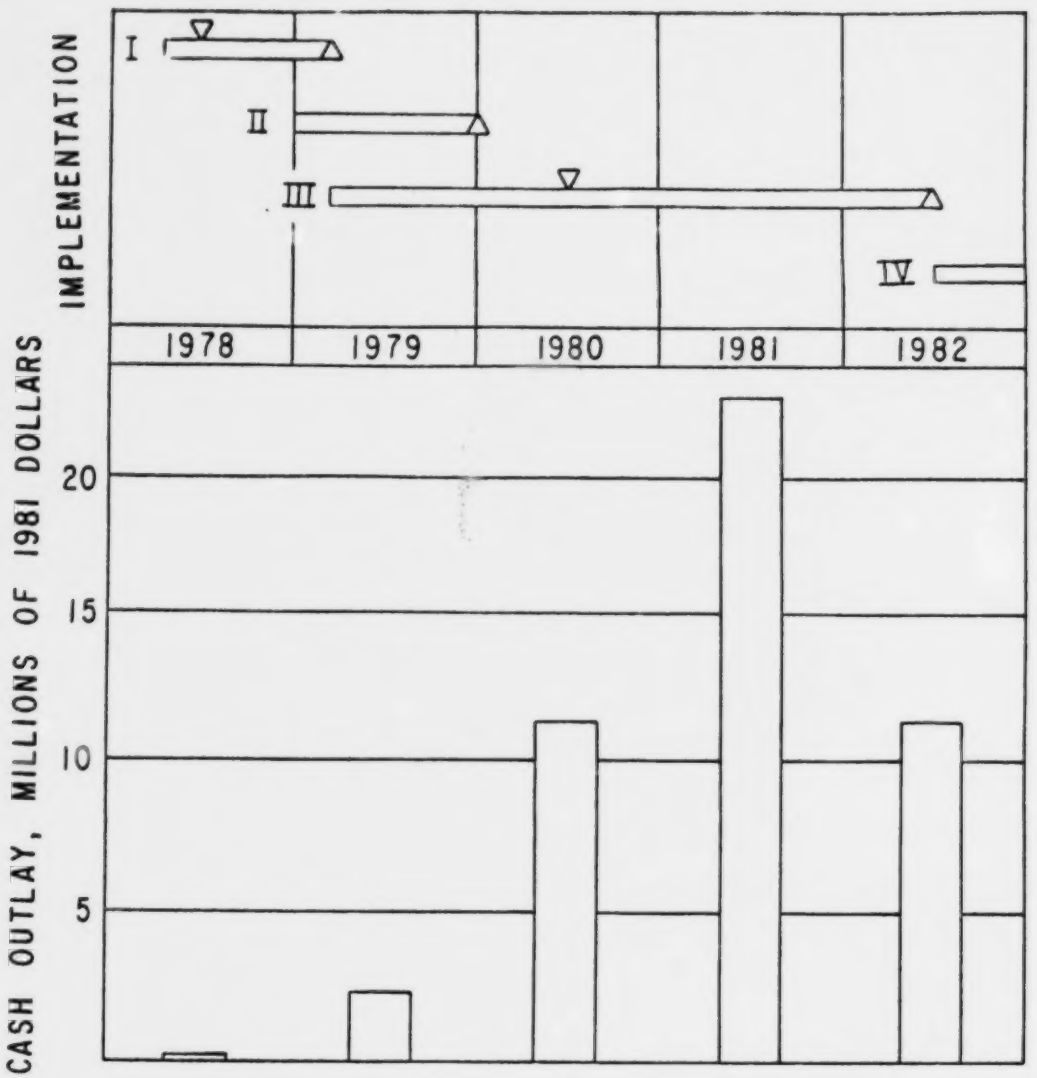
(Thousands of Dollars)

	Existing System	Case I Coal Reference System	Case II Coal Cogeneration System	Case III Integrated Utility System
Operation and Maintenance Costs	$ 11,513	$ 12,557	$ 10,722	$ 9,641
Capital (July 1981)		$ 20,421	$ 40,260	$ 48,062
Incremental Capital versus Case I		---	$ 19,839	$ 27,641
Annual O&M Savings compared to Case I		---	$ 1,835	$ 2,916
Annual O&M Savings compared to Existing System		$ (1,044)	$ 791	$ 1,872
Present Value of O&M Savings compared to Case I[1]		---	$ 36,223	$ 57,562
Years to pay back capital in excess of Capital in Case I[2]		---	11 years	10 years
Interest rate of return[3]		---	13 %	15 %

1 Present value based on annual O&M savings escalated at 7% / year for 20 years and a discount rate of 6.5%.

2 Payback period based on annual O&M savings escalated at 7% / year and a discount rate of 6.5%.

3 Based on 20-year O&M savings escalated at 7% and the stated incremental capital requirement.



PHASE I: PLANNING, SYSTEM SELECTION & PRELIMINARY DESIGN

PHASE II: PROCUREMENT

PHASE III: FINAL DESIGN & CONSTRUCTION

PHASE IV: COMMERCIAL OPERATION

FIGURE 3

IMPLEMENTATION SCHEDULE AND CASH REQUIREMENTS

FOR AN IUS AT THE UNIVERSITY OF FLORIDA

operation cash outlays.

The initial phase of the project results in: (1) selection of the most appropriate design of the IUS, including the solid waste subsystems; (2) decisions on the risk postures of the participants in the project and on the best methods for procuring the facilities and equipment, for purchasing coal and electricity, and for securing the supply of solid waste; (3) decisions on organizational/institutional requirements and responsibilities for project implementation; and (4) definition of the legal and permit requirements which the project must meet. If the selected system includes processing of Gainesville/Alachua County area solid waste, the considerations associated with completing this phase of the project become more complex.

Of considerable importance to achieving the desired results of Phase I is the development of detailed data and information on the University's energy usage, on solid waste management in Alachua County, and on the contractual requirements of Florida Power Corporation and the Regional Utilities Board.

The procurement phase of the project would include four major areas of effort:

- The procurement of services and equipment to accomplish the design and installation of the IUS.
- Negotiation of a contract for the long-term supply of coal.
- Negotiation of a contract for the purchase of electricity.
- Negotiation of a contract (or contracts) with municipalities in the County for the disposal of their solid waste or, possibly, for the purchase of dRDF produced in their resource recovery facility.

During the design and construction phase of the project, the University will need to accomplish several tasks to assure that the project is successfully implemented. The first key task is to assure that design and construction of all subsystems is scheduled properly and that schedule adjustments during construction do not result in, for example, dRDF being available before the boiler is installed and operating. The second key task is to ascertain that contractors have met

their design or performance specifications and that change orders, claims of Force Majeure and the like are rigorously managed. Both of these tasks may require that the University engage a consulting engineer to monitor the entire design/construction process. The third major task is to secure all of the permits necessary to start construction and begin operations.

Conclusions

It is reasonable to expect that the University will have to add coal-fired rather than oil-fired boiler capacity when it replaces current equipment. In this context, the analysis and assessment of the proposed Integrated Utility System leads toward certain conclusions concerning the quality of the concept:

- FIRST, it appears that the O&M costs saved as a result of implementing the IUS will result in a "pay-back" of the incremental capital investment in about 10 years.
- SECOND, although the IUS would use about the same raw fuel energy input as either the existing system or the coal reference system, its implementation will result in considerable savings of scarce and nonreplenishable fuels.
- THIRD, if the solid waste management systems perform as predicted, considerable conservation of non-renewable energy resources would result. (Coincidentally, the University of Florida would be demonstrating technology which may be transferrable to similar sized communities which presently are searching for economically feasible approaches to resource recovery).
- FOURTH, demonstration of the IUS could lead toward the identification and development of similar opportunities for cost and energy savings at other state institutions. In addition, implementation of the IUS will demonstrate the leadership of the State in efforts to economically conserve scarce natural resources and to utilize various forms of waste materials and energy.

- FIFTH, there is evidence that an IUS can be implemented by the agencies which are, or could be, involved in the Project. The most challenging implementation task will be the technical, economic, and institutional integration of the solid waste processing system with the cogeneration system.

In summary, it is concluded that an Integrated Utility System at the University of Florida utilizing coal, University solid waste, and solid waste from the surrounding community will provide the energy required by the University in a cost-effective manner. In addition, there will be significant reduction in the University's dependence on oil and natural gas. As side benefits to this program, the IUS system could protect the University from rapidly inflating gas and oil prices as well as provide an environmentally sound method of solid waste management to the area.

Recommendation

The results of this study, and of the previous Department of Health, Education, and Welfare/National Bureau of Standards - sponsored study, indicate that the University should proceed with the first phase of the project. Of particular importance is that effort now be focused on such questions as cannot be conclusively answered as a result of this and the previous study. Thus, completion of an energy systems analysis, conduct of a regional survey of solid waste, and development of a preliminary design (including a detailed economic analysis) of the most cost effective Integrated Utility System will provide the University and the State of Florida with a sound basis for deciding to proceed with final design and construction.

CHAPTER 2

AN INTEGRATED UTILITY SYSTEM AT THE UNIVERSITY OF FLORIDA

Background

The University's existing utility system provides heating, electrical power, cooling, potable water, solid waste disposal and liquid waste treatment essentially as independent services. A brief description of the system follows and a more detailed description is presented in Appendix A.

Steam is generated in a central boiler house located at the southern edge of the campus. Two of the five oil/gas boilers (including the new 120,000 lb/hr unit) are considered operational and a third unit is being repaired to bring it back on line. The remaining two oil/gas boilers are over 20 years old and have been placed in reserve service. The plant is operated to generate 250 psig, 500F steam to meet the University's heating requirements and to operate some power production and air conditioning equipment.

Electrical power is purchased from Florida Power Corporation, but approximately five percent of the University's needs are being met with an existing 1 MW backpressure turbine run in parallel to existing steam driven centrifugal chillers and a pressure reducing station. The low pressure exhaust steam is distributed through a steam main system to the campus.

Chilled water for air conditioning campus facilities is provided by both new electrically driven and older steam driven centrifugal chillers. The University's chiller capacity is presently 13,000 tons with a planned expansion of another 3,000 tons to meet the needs as more buildings are brought onto the more efficient central plant and less efficient small satellite units are retired. The old steam driven chillers might also be retired because they are relatively inefficient and expensive to operate.

Solid waste from the University is presently collected, compacted, and taken to a landfill for disposal. This 18 TPD_7^* of high paper content waste is disposed along with an estimated additional 250 TPD_7^* of waste from the Gainesville area. Assuming that people will continue to produce the same amount of solid waste and accounting for projected increases in

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* Subscript denotes days in working week.

County population, the solid waste to be managed by the year 2,000 could increase to 370 TPD.

Undoubtedly, all the University's utility services are essential to the continued operation of the University. The question that has to be raised and must be answered is, "Can the University's utility needs be met in a more cost effective and energy conserving manner?"

There are a number of reasons why the University should evaluate alternatives to the existing utility system. Some of the issues follow:

a) Commercial utility systems operate at relatively low thermal efficiencies because condenser heat is rejected to the atmosphere instead of being used. This is an inefficient use of fuels.

b) The University's primary fuel, currently natural gas, is a scarce, nonrenewable fuel. This supply has been curtailed in the past and will undoubtedly be even less available in the future because of its preferred use as a feedstock in chemical industry, use for residential heating, and federally mandated curtailment for major fuel burning installation (MFBIs) which would include the University's facility. Additionally, the cost of gas has been rising rapidly, and the effect of deregulation will contribute to higher costs in the future.

c) The University's standby fuel, No. 6 fuel oil, is also subject to rapid price escalation due to international market forces and future domestic deregulation. State regulations will require that the oil burned by the University be low sulfur oil which will result in even higher prices. If the national policy is to reduce the balance of trade deficit by reducing the nation's dependence on foreign oil, the University has a shared responsibility by minimizing usage of No. 6 fuel oil.

d) Alternative domestic energy resources, coal and solid waste are available to replace scarce fuels.

e) Solid waste contains a combustible fraction which can be converted into usable energy. Solid waste derived energy has the advantages

of displacing scarce and nonrenewable fuels and conserving the land by reducing landfill requirements.

f) It is anticipated that the cost of purchased electrical power will rise at a rate greater than the rate of increase for non-scarce fuels purchased by the University. Therefore, University generated power becomes cost beneficial.

g) Solid waste contains a metal fraction consisting primarily of iron, which can be magnetically removed and sold as scrap for reuse. The recovery and reuse of magnetic materials has the combined effect of producing revenues and reducing landfill requirements.

h) Landfilling of putrescible refuse (garbage) has possible negative environmental impacts including release of methane gas and release of leachate (landfill wastewater) containing biological and chemical contaminants, organic material and dissolved materials. Leachate movement into the groundwater should be of concern since nearly the entire county relies on groundwater from either a shallow water table aquifer, a secondary artesian aquifer, or the Floridan aquifer. These potential environmental dangers could be reduced by processing the solid waste in a resource recovery system.

The concept of an Integrated Utility System (IUS) such as that displayed in Figure 4 to generate electrical power while simultaneously providing all of the thermal (space heating, domestic uses, space cooling) services is a proven tencnology that addresses the issues, and concerns stated above while satisfying community energy requirements. Annual operating and maintenance costs can be reduced while conserving energy and scarce fuel by integration of energy services. Further reduction in annual costs can be achieved by integrating the community's solid waste disposal to produce a fuel substitute, thereby displacing and conserving an equivalent amount of non-renewable raw fuel energy input. Hence, an IUS at the University of Florida would combine the best attributes of power production, steam generation and waste management to meet many of the University's utility needs, while conserving money and nonrenewable fuels.

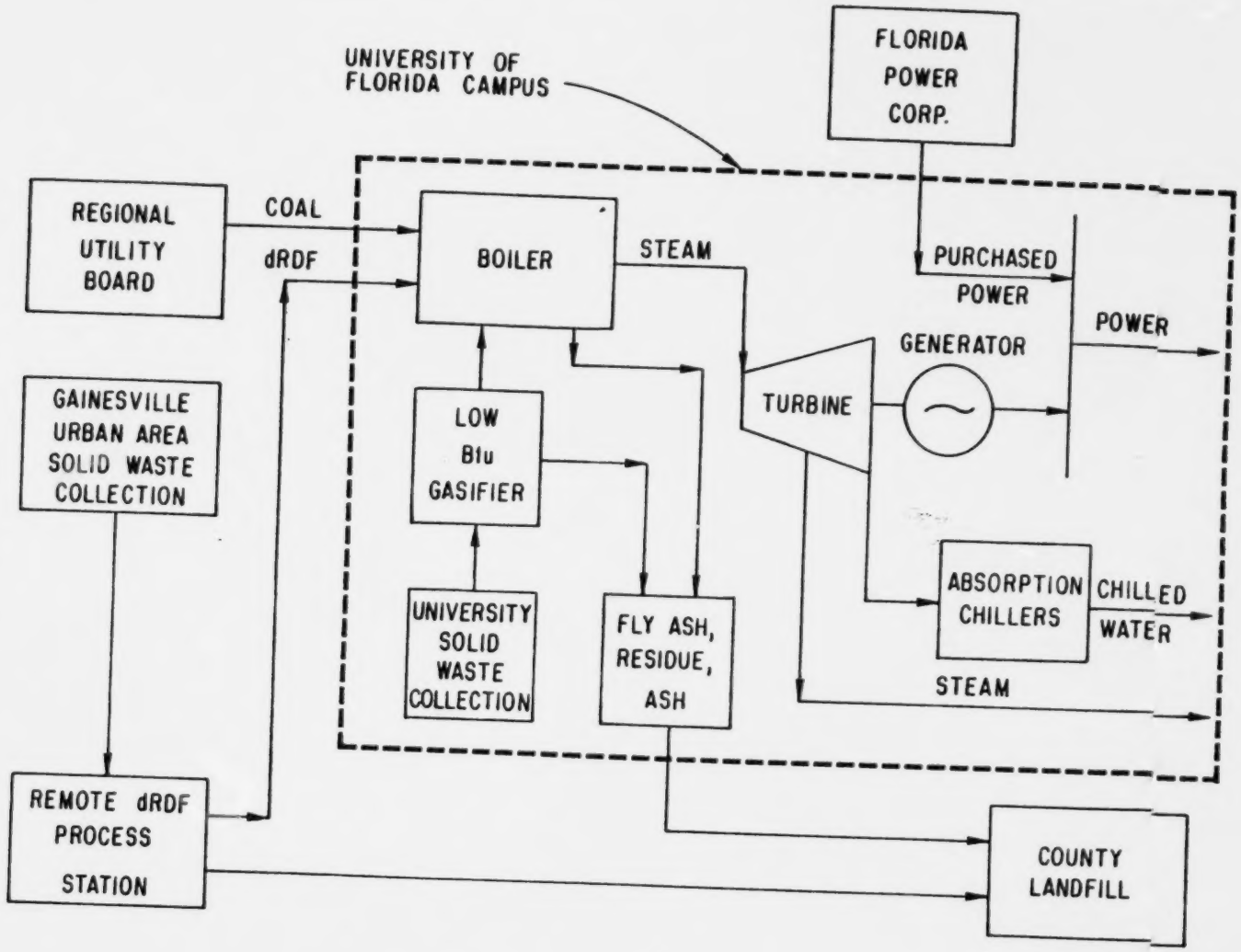


FIGURE 4

CONCEPTUAL RELATIONSHIP OF THE SUBSYSTEMS NEEDED TO DEVELOP AN IUS AT THE UNIVERSITY OF FLORIDA

The Original Evaluation

In October, 1976, work sponsored by the U. S. National Bureau of Standards and U. S. Department of Health, Education and Welfare considering the development of an IUS for the University of Florida was culminated by the publication of a report on the feasibility of an IUS at the University of Florida prepared by Reynolds, Smith and Hills, Architects, Engineers and Planners of Jacksonville, Florida. This study identified the methods by which the Integrated Utility System (IUS) concept could be applied to the University of Florida campus in Gainseville.

As a result of this study, it was concluded that an Integrated Utility System at the University of Florida utilizing coal, University solid waste, and solid waste from the surrounding community could reduce the amount of scarce fuels required to generate the electrical power consumed by the University and supply the low pressure steam needs in a cost-effective manner.

In the 1-1/2 years that have elapsed since the initial study was completed, economic conditions have changed. Hence, the University of Florida requested both the Department of Energy and the Environmental Protection Agency to assess expeditiously the IUS feasibility oriented towards:

1) Updating the capital costs of the project to account for recent construction cost escalation.
2) Revise the operating and mantenance cost savings projections recognizing the changing energy climate and costs.
3) Confirm or deny the overall reasonableness of implementing an IUS at the University of Florida.

The remainder of this section deals with an IUS concept which has evolved from the original University of Florida study updated with current capital cost estimates, revised energy availability and cost scenarios, and utilizing the latest developmental technology for solid waste management and energy recovery.

IUS System Description

Because this evaluation is an update of previous work and not a new study, the published Reynolds, Smith & Hills report is used as a basis for defining the IUS. The method of introducing solid waste into the system was modified from the original work to reflect changes in solid waste management technology which have occurred since the original study was completed. The reader must be cautioned that other systems exist which could also be used to implement an integrated utility system concept at the University of Florida. It is not believed, however, that optimizing the system on an energy or cash basis will cause changes outside the error limits of the results from the analyzed IUS.

If the analyzed IUS had been redefined to maximize the efficiency of electrical generation, too much power would be produced which the University would have to sell to another energy user. Because of the institutional complexity of this type of arrangement and the small increment of energy efficiency gain to be realized by the University of Florida there was not sufficient justification for the University to become a power retailer.

Cogeneration Subsystem - The integrated utility system (IUS) analyzed for the University of Florida uses a coal-fired spreader stoker equipped boiler to generate moderate pressure and temperature steam for power production in an extracting, backpressure turbine with the low pressure steam being used to meet the University's existing steam requirements and drive new absorption chillers. Figure 5 is a schematic layout of the conceptual congeneration subsystem.

Coal and dRDF (densified refuse derived fuel prepared in another subsystem) are received in a covered, dust controlled tipping building and blended during placement into the eight fuel storage silos. The blended fuel is outfed from the silos through enclosed screw-auger conveyors into the boiler feeders. These boilers are partially factory assembled 150,000lb/hr water wall boilers designed to produce 875 psig, 900 F steam and equipped with convective superheaters and economizers. The fuel will be introduced into the boilers through spreader stokers. The ash from burning the coal and dRDF on the grate will be collected and pneumatically transported to an ash silo. Cinders collected at the boiler outlet have fuel value, so they

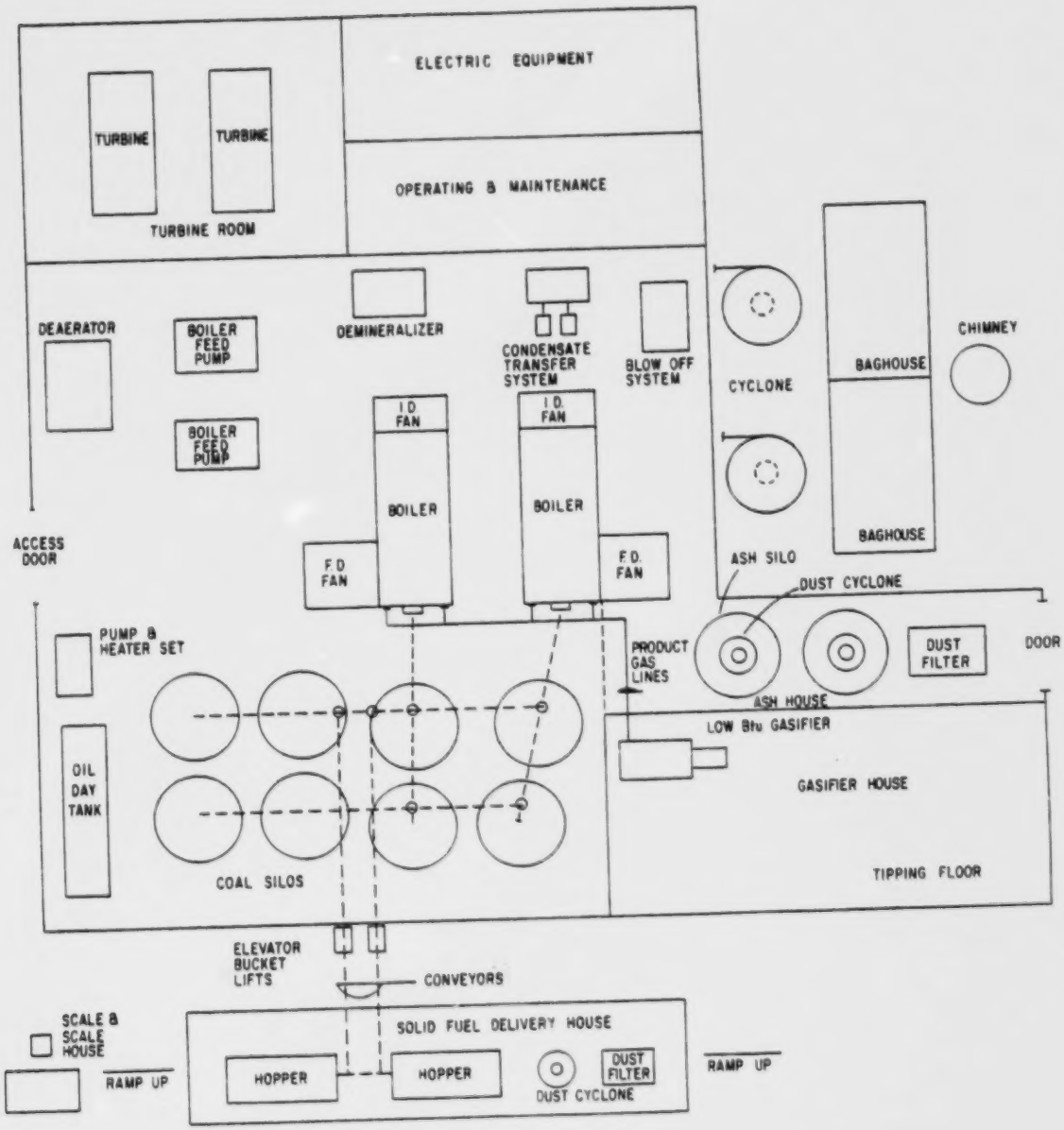


FIGURE 5
CONCEPTUAL LAYOUT OF
THE COGENERATION PLANT
AND GASIFIER HOUSE

will be reinjected into the furnace to complete combustion and improve overall furnace efficiency. The fine particulates in the flue gas will be removed using cyclones and a reverse pulse bag house. The particulate free products of combustion will then discharge through a stack elevated at least two and a half times above the nearby buildings to prevent ground level pollution and provide adequate dispersion of gases to protect the ambient air quality.

The steam from the boilers will be fed to two identical 7500 kilowatt extracting, backpressure turbines to generate electricity and produce 75 psig steam for use on the campus and 15 psig steam for the new absorption chiller. In order to facilitate load matching, the system has been equipped with variable capacity regenerative feedwater heaters to utilize the energy of low pressure exhaust steam which bypasses the chillers and/or distribution system. An additional extraction port can be included to provide 250 psig steam to drive the University's existing steam-driven centrifugal chillers if this proves to be economically beneficial during preliminary design. For the purpose of this analysis, it has been assumed that the relatively inefficient steam-driven centrifugal chillers will be retired and the capacity replaced with new absorption chillers.

Feedwater for the unit will be provided by condensate returned from the University and the absorption chillers, and demineralizer treated potable city water. Boiler blowdown will be cooled to recover much of its energy and then it will be rejected to the sanitary sewer for polishing in the University's wastewater treatment plant.

University Solid Waste Gasification Subsystem - The University of Florida generates approximately 18 TPD_7 of solid waste. Because the principle sources of solid waste in the University are the dormitories, cafeterias, and offices; the waste has little wet garbage and other low heating value components normally found in mixed municipal waste. As a result, this is a relatively high energy (5,000 Btu/lb) waste source.

The University waste would be introduced into a refractory vessel along with too little air for complete combustion. As the waste burns, gases leaving the primary combustion chamber will contain considerable amounts of carbon monoxide, smoke, soot and other combustible gases, which will serve as an energy source. (This gas resembles producer gas

used in many American cities in the late 19th century.) This gas will be ducted through a high temperature refractory-lined breaching to a burner connected to the new coal boiler.

While this application of controlled air incinerator technology has not been implemented as a system, the subcomponent technology has been previously demonstrated. Integrating this subsystem with the overall IUS has the additional benefit of saving the University the costs of hauling unprocessed solid waste to a central disposal facility.

Regional Solid Waste Processing Subsystem - Because the boiler selected for the University of Florida is a spreader stoker-equipped unit, it is advantageous to prepare a fuel from the solid waste which can then be transported to and handled through the University of Florida plant without any facility or site modifications. Such a fuel, commonly called densified refuse derived fuel or dRDF, has been shown in a series of recent experiments to be a suitable stoker coal substitute.* Since it is well known that a successful resource recovery plant requires a market for energy, the plant conceived for the Gainesville/Alachua County area creates a fuel which is readily usable by the conceptual IUS for the University.

Maximum benefit can be gained from resource recovery if the plant is centrally located off the University grounds to minimize haul distances. Because Gainesville/Alachua County has a relatively small amount of solid waste available (less that 250 TPD_7) it was decided to recover only the high value, readily separated components of the waste stream while continuing to rely upon the landfill to dispose of a significant protion of the waste stream. The concept results in more than a 70 percent reduction in the volume of waste to be disposed.

The conceptual process plant layout is shown in Figure 6. Solid waste arrives on a tipping floor and is pushed with a front-end loader onto the conveyor feeding a primary trommel screen. In the trommel, all

*Rigo, H.G., et al. A Field Test Using Coal: dRDF Blends in Spreader Stoker Fired Boilers, EPA Contract 68-03-2426, May, 1978.

An hourly energy balance based on annual average hourly loads for the analyzed IUS is shown in Figure 7. By burning approximately 13 tons an hour of 12,000 Btu per lb. of coal, the University will generate an average of 186,000 lbs. per hour of 850 psig, 900 F steam. This steam will be fed through two 7,500 kw turbines to generate 11,500 kw of power averaged across the entire year. Some of this power will come from steam extracted at 75 psig to meet the University's distribution steam requirements and the rest from steam reduced to 15 psig pressure in the backpressure turbine to meet the requirements of an annual average of 4,000 tons/hr of new absorption chiller load. By operating the absorption chillers in lieu of electric chillers, the University can reduce electrical consumption by 3,600 KWH per hour (assuming that the absorption chillers will displace at least this much of otherwise electrically-driven load). Use of steam in this manner to produce chilled water will allow the University to offset the purchase of an average of 15,100 KWH per hour of electricity.

Converted into annual requirements, the IUS will combust approximately 114,700 tons per year of coal if no waste is utilized. With this amount of coal, approximately 100.7 million KWH of electrical power will be generated resulting in the need to purchase only 13.1 million KWH of electricity. The use of absorption chillers has the effect of reducing the University's electrical load by 31.5 million KWHR/YR.

Figure 8 shows an energy efficiency diagram for the solid waste gasification subsystem. University waste introduced into the primary chamber produces gas at 1,600°F which has both sensible heat and a residual heat of combustion, it will burn at a conversion efficiency of 93 percent. Approximately 81 percent of the energy in this hot gas stream reaching the boiler will then be recovered in the form of steam. Therefore, the overall energy efficiency of converting University waste into steam is 75 percent.

Using the 6,500 TPY of University waste in lieu of firing coal in the boilers conserves 2,923 tons per year of coal. In other words, the effect of using the University waste in the controlled air gasifier is to offset the purchase of almost 3,000 tons per year of coal. Secondary savings in labor and fuel not used to transport the waste to

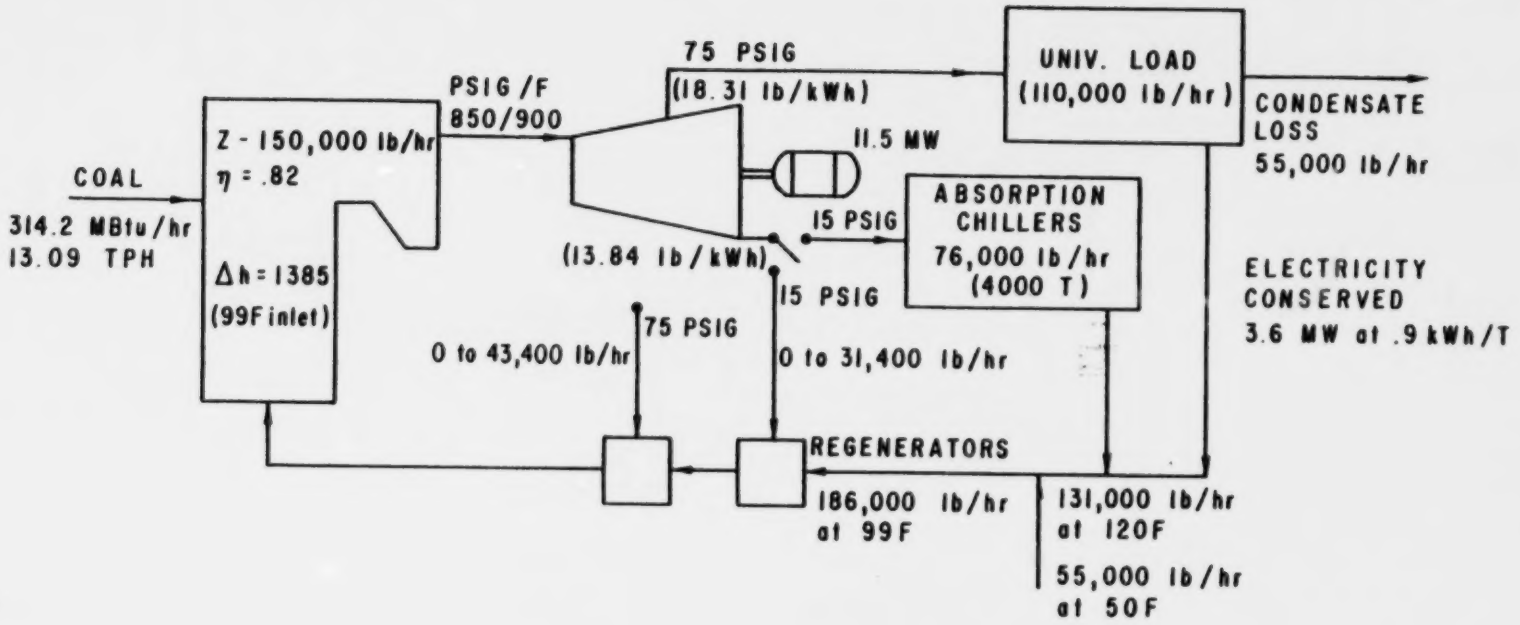


FIGURE 7

AVERAGE HOURLY ENERGY BALANCE FOR THE ANALYZED IUS

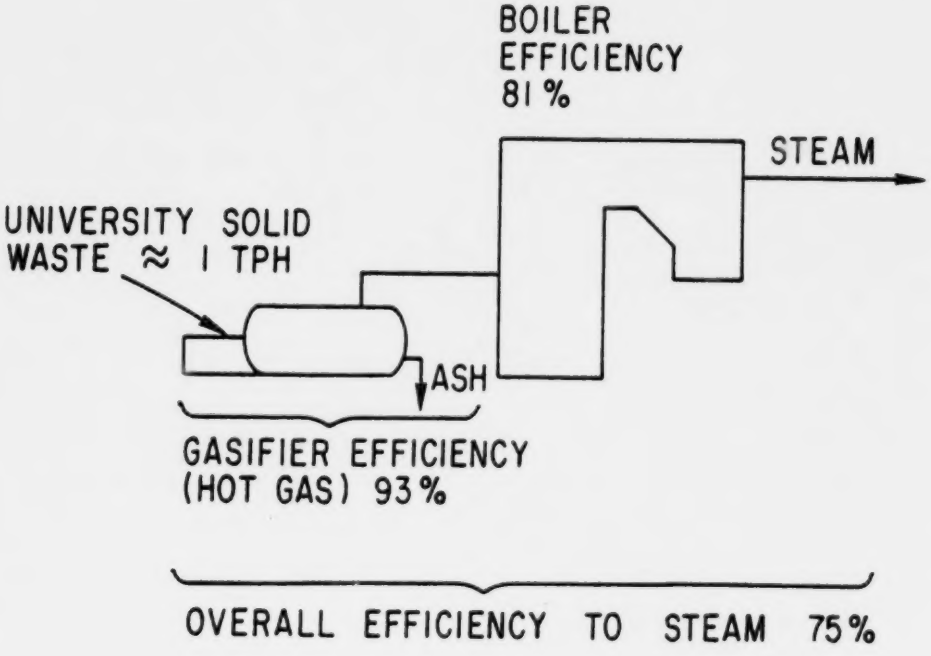


FIGURE 8
ENERGY BALANCE FOR THE
CONTROLLED AIR GASIFIER CONVERTING
UNIVERSITY SOLID WASTE
INTO A BOILER FUEL

the landfill would also be realized.

Figure 9 is a mass flow balance for the Gainesville/Alachua County dRDF subsystem. Each ton of solid waste delivered to the tipping floor will yield approximately 0.5 ton of dRDF and represents recovery of 68 percent of the energy in the raw solid waste.

The availability of solid waste for the Gainesville/Alachua County urban area is shown in Figure 10. Processing the Gainesville/Alachua County waste through the plant could yield in 1982-1983, the first plant operating year, approximately 150 TPD_7, or 55,000 tons of dRDF if all waste in the County is taken to the plant. One hundred percent capture of the county waste is unlikely, thus a reduced yield should be anticipated. Because the county population and waste generation are expected to increase over the life of the project, an average dRDF production of 127 TPD_7 has been estimated to account for regional growth while allowing for only 75 percent capture of the available waste.

The project average of 46,355 tons per year of dRDF generated by the Gainesville regional solid waste plant would conserve approximately 22,700 tons per year of coal at the 79 percent boiler efficiency characteristic of firing dRDF in the specified boilers.

Energy and Fuel Conservation

The conceptual IUS for the University of Florida uses somewhat less total energy than the existing system. Because the existing University System produces steam utilizing gas/oil with a conversion efficiency of 89 percent compared to a coal-fired system which generates steam at 82 percent efficiency; improvements in system efficiency and hence energy utilization will be reduced by the differential conversion efficiency. Similarly, the combustion of solid waste derived fuels which have lower boiler efficiencies result in almost equivalent total energy requirements to the present system.

Therefore, as illustrated by Figure 11, the IUS saves 100 billion Btu/yr compared to the existing system and 200 billion Btu/yr compared to the Case I Coal Reference System.

There is, however, a significant reduction in the energy required to generate electrical power for the IUS compared to a large central

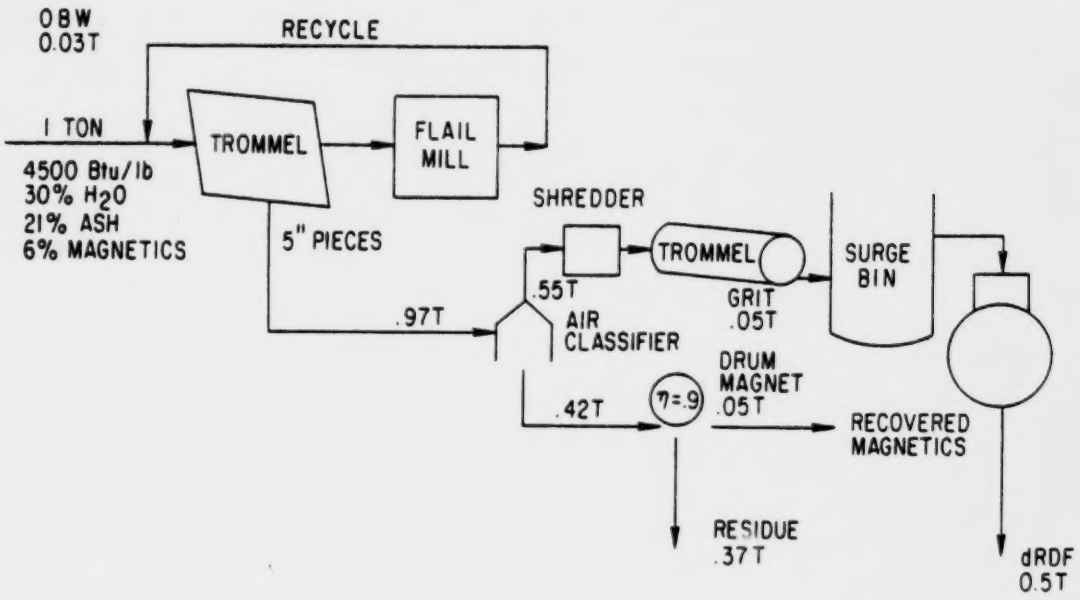
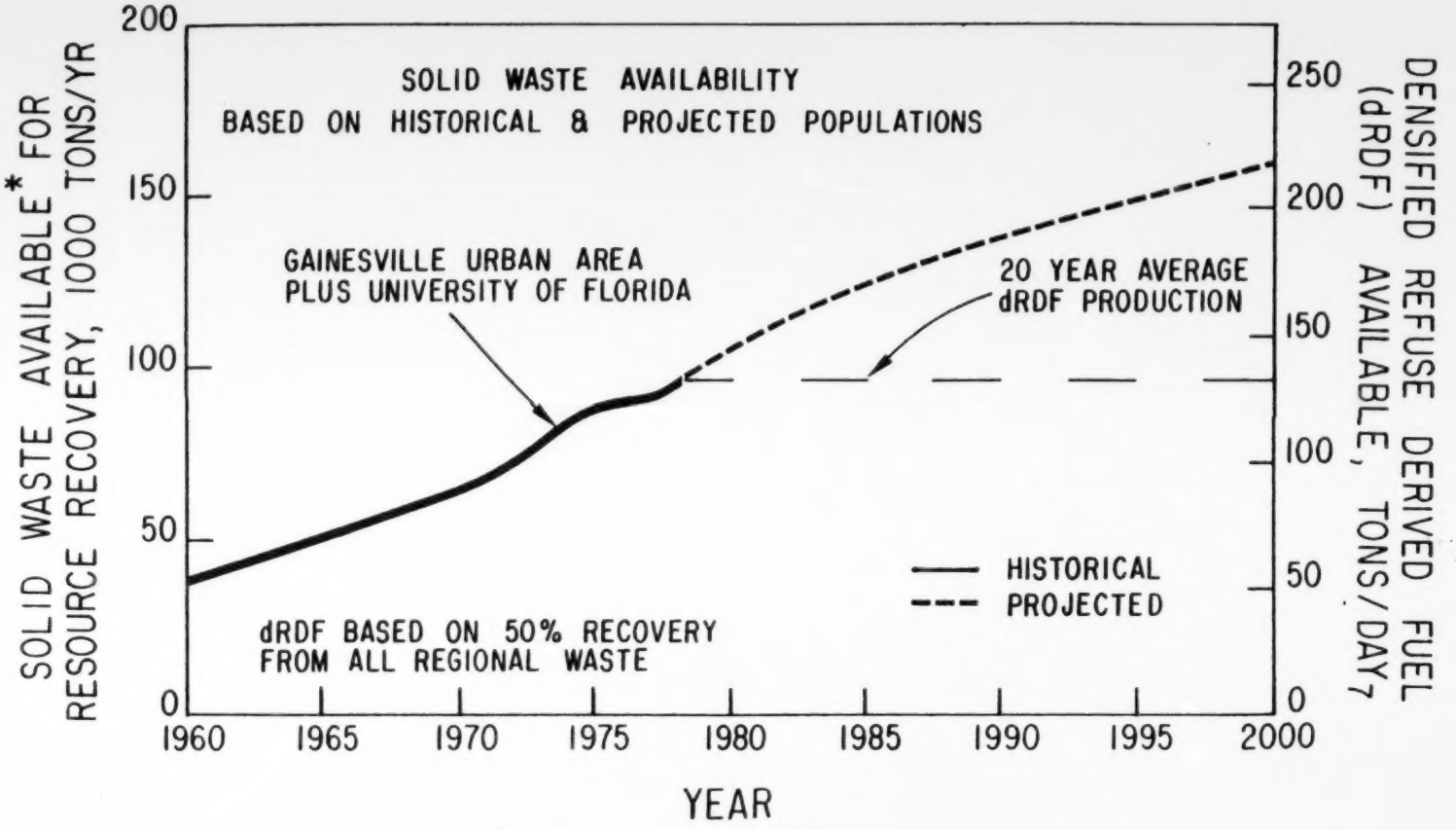


FIGURE 9

MASS BALANCE FOR THE

REGIONAL DENSIFIED REFUSE DERIVED FUEL

TRANSFER/PROCESS STATION



* HISTORICAL SOLID WASTE AVAILABILITY BASED ON UNIVERSITY RECORDS AND DATA FROM "FINAL REPORT, PHASE I SOLID WASTE MANAGEMENT STUDY" BY NORTH CENTRAL FLORIDA REGIONAL PLANNING COUNCIL AND ENVIRONMENTAL SCIENCE AMD ENGINEERING INC., 1973. PROJECTED SOLID WASTE AVAILABILITY BASED ON 3.5 LB/CAP/DA

FIGURE 10

THEORETICAL SOLID WASTE AND dRDF

AVAILABILITY FROM COUNTY SOLID WASTE

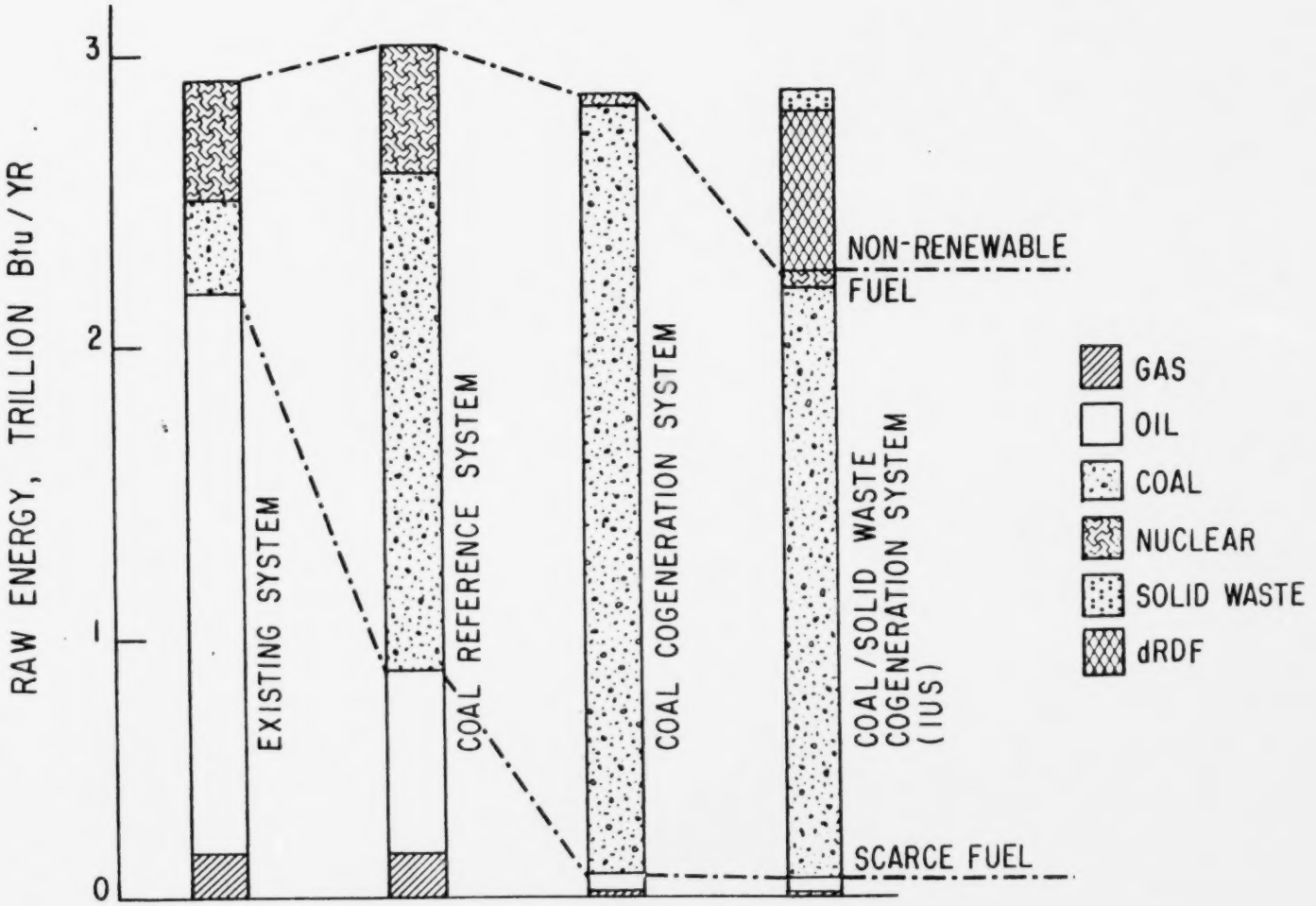


FIGURE 11

COMPARISON OF ENERGY AMOUNT AND MIX USED
TO SUPPORT UNIVERSITY OF FLORIDA
NEEDS USING DIFFERENT SYSTEMS

utility system. With the integrated system, low quality heat from generating power is used to provide University thermal services; whereas, for a central power plant the energy not converted into electrical power is typically rejected to the atmosphere. Thermodynamically the conceptual system for the University of Florida requires approximately 5,900 Btu per Kilowatt-hour as compared to a remote generating station using almost 11,400 Btu per Kilowatt-hour including transmission line losses.

Most significantly though there is a scarce fuels savings of almost 2.2 Trillion Btu per year or 95 percent of the raw fuel energy input that would otherwise be consumed by the existing system by operating a coal reference system or the coal cogeneration plant. Equivalent amounts of oil and natural gas which can be used for other purposes would not be burned in the plant. Instead, the University of Florida would be firing coal, a nonrenewable but more plentiful energy resource.

The conceptual IUS for the University of Florida utilizes both coal and solid waste fuels. In addition to the savings noted above, the use of solid waste would save approximately 600 billion Btu/yr of nonrenewable fuel resources. Since solid waste is presently a disposal commodity, it can be considered that the waste components are of themselves of no significant energy value. Hence, the IUS analyzed would conserve almost 21 percent of the raw fuel energy input which the University is now using.

Environmental Assessment

Air Pollution - The IUS at the University of Florida will burn coal, dRDF and solid waste. It will be designed to comply with air pollution control regulations and apply best available technology such as, the installation of high efficiency bag house filters to control flue gas particulate emissions.

The IUS plant will be firing coal with 0.7 percent sulfur content. The blend of refuse and coal results in a fuel having a 0.6 percent coal equivalent sulfur content. It is anticipated that the plant will comply with applicable ambient standards assuming a stack height approximately 2 1/2 times the height of nearby buildings. Since the Florida DER has indicated it will permit a power plant burning this coal without the

installation of SO_x scrubbers, it is presumed that this plant can be similarly permitted after appropriate dispersion modeling studies.

Besides point source air emissions from the combustion of coal, dRDF and solid waste in the University of Florida IUS boilers, fugitive (in plant) dust will result from the handling of these fuels within the IUS plant and remote dRDF processing plant. Since each of these potential problem areas are enclosed and will be equipped with dust collection systems, fugitive emissions will be controlled. The air classifier in the regional resource recovery plant will be equipped with fabric filters to remove entrained dust before the air is returned to the atmosphere. In summary, all dust producing elements of the IUS and ancillary equipment will be installed with appropriate pollution control equipment to meet applicable regulations. Therefore, the plants are expected to be good neighbors and will protect the environment.

Water Pollution - The IUS plant will produce a different quality of demineralizer waste water and boiler blowdown than the existing University facility. Because these waters are generally easily managed in municipal waste treatment plants, their collection and discharge along with normal housekeeping and sanitary waters to the University treatment plant should provide adequate environmental protection. If the University of Florida were to begin disposing all their liquid waste in regional waste water treatment facilities, the environmental impact of these wastes would be even further reduced. The disposal of boiler blowdown in the sanitary sewer instead of its present discharge to Lake Alice, would result in a small but potentially significant improvement in the water quality of the lake.

Noise Pollution - The plant design will enclose all rotating equipment and truck unloading operations. These walls should provide sufficent noise barriers and few, if any, additional design considerations will be necessary to comply with existing and/or proposed federal and state criterion.

There will be approximately 18 trucks a day arriving at the boiler facility, five days a week, during daylight hours to deliver coal and densified refuse derived fuel. Another three to four trucks a day will be hauling ash to the landfill for a total of 22 round-trips per day.

These trucks should not create unacceptable noise impacts since the terrain is level and gear shifting can be minimized. The increase in traffic volume will be uniformly spread throughtout the working day and will be small enough that any potential irritation caused by the truck traffic at the perimeter of the University should be minimal.

Land Pollution - It is difficult to determine what the exact impact of this process will be on the land. At the present time, there are no residues from the University power plant to be disposed, but all of the solid waste from the University and the Gainesville area is placed in sanitary landfills. With the implementation of the IUS at the University of Florida, bottom and fly ash from the boilers will need to be disposed. Incinerator residue from the controlled air incinerator gasifier will be produced, and residues from the resource recovery facility will be created which must also be landfilled. The impact of disposing of the incinerator residue from the University controlled-air incinerator residue from the University controlled-air incinerator/ gasifier compared to the impact of disposing the raw solid waste from which it comes, is unknown. The incineration process will substantially eliminate the organic substrate needed for micro-organisms to grow and create the organic portions of leachate. The inorganic ash remaining has the same quantity and types of chemicals as in the inorganic structure of the raw waste. The availability of these chemicals for leeching is, however, possibly changed due to ash heating in a reducing atmosphere.

On balance, therefore, an adverse net impact on the land is not expected. It must be realized, however, that there will be a significant reduction in the total amount of material to be land disposed. This means that there is probably a beneficial effect of implementing an IUS plant utilizing resource recovery in the University of Florida/ Gainesville area.

Economic Analysis

Alternatives to be Analyzed - Presently, the University uses a gas/oil-fired steam boiler system to meet its space heating needs. Some steam is also used to provide a small portion of its electrical and chilled water needs. Analysis of the existing steam plant at the University

indicates a need to install another new boiler within the next several years. University plans suggest that the new boiler will have to have 120,000 lb/hr of capacity. Pending Federal energy legislation will prohibit the construction of Major Fuel Burning Installations (MFBI's) designed to burn oil or natural gas as primary fuels. Since the planned new boiler falls well within the definition of an MFBI (100 Million Btu/hr input), it is unlikely that the University will be allowed to install a gas/oil boiler. Instead the University will have to provide future steam capacity by installing boiler systems designed to burn coal or some other fuel which is less scarce than gas and oil.

Due to MFBI regulations, the economics of future alternative utility systems cannot be based on the costs associated with the installation of an oil/gas boiler but instead must be based on a replacement boiler that burns coal. The economic information contained in this report, therefore, considers the economic benefits of installing two alternative coal-burning utility systems relative to a reference system consisting of the existing oil/gas plant and a new base-loaded coal fired boiler. Throughout the remainder of this section the alternative utility systems will be defined as three distinct cases:

Case I is a COAL REFERENCE SYSTEM which utilizes the design philosophy of the existing system and replacing outdated equipment with a 120,000 lb/hr coal-fired boiler. Using this system, a major quantity of steam production will result from coal burning. The total plant capacity under this scenario would be 290,000 lb/hr.

Case II is the installation of a 300,000 lb/hr COAL COGENERATION SYSTEM to replace all of the existing oil/gas boiler capacity. Two 150,000 lb/hr coal-fired boilers would generate steam to provide all of University's space heating needs, a major portion of the electricity requirements, and a portion of the air conditioning requirements using absorption chillers.

Case III is the installation of a 300,000 lb/hr INTEGRATED UTILITY SYSTEM (IUS) designed to replace all of the existing oil/gas capacity. Two 150,000 lb/hr coal/solid waste-fired boilers would generate steam to provide all of the University's space heating needs, a major portion of the electricity requirements, and a portion of the air conditioning requirements (using absorption chillers). The key difference between Case III and Case II is that solid waste replaces a portion of the coal.

Although details of the various cases have been discussed in previous sections of this report, it may be helpful to understand the similarities and differences of the three cases by referring to Table 2. This table summarizes the design and operating parameters of the alternative cases and the University's existing oil/gas system. Major differences between the three alternative cases are in the areas of steam production, fuel mix, fuel consumption, ash disposal, electrical power purchases, absorption chiller capacity, and number of required operating personnel.

Methodology of Economic Analysis - Since incremental capital frequently produces incremental savings, the problem of comparing alternatives is that of determining whether an incremented expenditure of capital is justified. If economic factors indicate incremental capital expenditures would be more than offset by annual operating cost savings, then the additional investment may be warranted.

During this study, three measures were employed to compare the relative cost effectiveness of alternative systems. The measures were used to evaluate the attractiveness of the O&M savings of Cases II and III (Coal Cogeneration and the IUS) versus Case I (Coal Reference). Since some new construction will eventually be needed, the relevant question is whether the existing plant should be simply expanded or a more energy efficient option should be constructed.

The first economic measure utilized is the 20 year present worth of the incremental O&M savings associated with Coal Cogeneration and the IUS. If the present worth of the O&M savings exceeds the required

TABLE 2

Comparison of Utility Plant Design
and Operating Parameters (2)

	Existing System	Coal Reference System	Coal Cogeneration System	Coal/ Solid Waste Cogeneration System (1) (IUS)
Steam				
Pressure - psig	265	265	875	875
Temperature - F	500	500	900	900
1,000 lb/hr - Avg.	110	110	186	186
Fuel Consumption				
Oil - gal/yr	9,138,600	1,827,800		
Coal - TPY		47,280	114,700	89,100
dRDF - TPY				46,400
SW - TPY				6,500
Electricity - 10^6 kWh/yr				
Campus Requirements	143.0	143.0	111.5	111.5
Incremental Plant Auxiliaries	NA	2.0	2.3	3.1
Total Power Required	143.0	145.0	113.8	114.6
University Generated Power	5.5	5.5	100.7	100.7
Power Purchased	137.5	139.5	13.1	13.9
Power Conserved	-	-	31.5	31.5
Peak Electrical Demand MW/mo	28.5	28.7	22.0	22.1
Absorption Cooling				
Tons/hr - Avg.	-	-	4,000	4,000
Fuel Mix - 10^{12} Btu/yr				
Scarce Fuels				
Gas	.16	.16	.01	.01
Oil	2.04	.73	.05	.05
Nonrenewable				
Coal	.31	1.73	2.77	2.15
Nuclear	.42	.42	.03	.03
Renewable				
dRDF				.56
Solid Waste				.08
Total Energy Input	2.93	3.04	2.86	2.88
Number of Plant Operating Personnel	26	78	52	57
Plant Water 10^6 gal/yr	87	100	101	101
Ash Disposal - TPY	NA	5,800	14,000	22,000

1 Does not include O&M items for the remote solid waste transfer/process station.

2 Zero growth senerio except for stepwise change in steam and electrical loads to account for absorption cooling.

incremental capital of an alternative, then it can be concluded that O&M savings repay the increased capital, and excess funds are available in later years to be used for additional projects.

The second economic indicator was the payback period associated with the incremental capital for the coal Cogeneratio and IUS projects. The object of this analysis was to determine the number of years it would take for the O&M savings to repay the corresponding incremental capital; this factor was calculated by determining when the present worth of cumulative O&M savings would equal the incremental capital. The payback period can be used to evaluate whether or not incremental capital should be invested by comparing the payback period with respect to the useful life of the facility. If the payback period is significantly lower than the useful life of the facility, which in this case has been assumed to be no less than 20 years, the investment is probably justified.

A third economic indicator was interest rate of return. Interest rate of return can be viewed as return on investment. In this analysis the "investment" would be the incremental capital associated either the coal cogeneration or IUS projects. The interest to be gained from this investment would be obtained from the O&M savings associated with the 20 year life of the project and can be loosely compared to the interest the investment would earn were the money put into securities instead of into the project. Hence, an interest rate of return in excess of returns from available securities indicate a sound State investment. The merits of incremental capital investment can be more strongly justified as the interest rate of return increases.

Background Information - As discussed previously, the process of implementing the project would make the selected alternative system available to meet University energy needs by about mid-1982. For this reason, capital costs associated with the alternative utility systems have been estimated at the midpoint of construction, mid-1981. Start-up of IUS would be expected to occur in mid-1982; therefore, all operation and maintenance costs are associated with the first year of operation beginning mid-1982.

In order to generate future construction and unit operation and maintenance cost estimates, it was necessary to escalate known cost

factors to 1983. The following annual inflation rates were utilized in determining the compound annual effects of escalating costs:

general inflation	6%
salaries	7%
maintenance	7%
coal	8%
oil	8%
electricity	10%
construction	10%

The economic impact of continued inflation on the University's utility system can be observed by comparing the operating and maintainence costs in 1977 of $6,447,00 (see appendix B) to projected 1982 costs of $11.5M.

The economic comparison of alternatives was based on a Coal Reference System. The developed economic data also contains information on projected costs of maintaining the existing oil/gas utility system. Although the addition of new oil/gas boilers is probably not an allowable option, the projected costs of a system burning low sulfur No. 6 fuel oil have been included to provide a frame of reference. The objectives of this comparison are to (a) determine the capital costs of the three cases being considered; (b) define the future operation and maintenance costs of the three cases and the existing oil/gas utility system; and (c) compare the economics of the three alternative utility systems.

In order to evaluate the capital and operation and maintenance costs of the alternative systems, a number of assumptions were made. A summary of these economic assumptions (adjusted to a 1982 basis) are shown in Table 3. Some of these economic factors are based on existing commodity rate data, (e.g., salary, electric rates, oil price, and water) while other factors are based on engineering data. These economic assumptions were applied to the design and operating parameters summarized in Table 2 to determine the 1981 systems costs.

It should be noted that the economic projections presented in this report are conservative budget estimates. Examples of conservatism are:

Table 3

Economic Assumptions Used in Evaluating Alternative Utility Systems for the University of Florida - Escalated to Mid-Year 1982

• Salary (Existing System) Direct and Indirect Cost	$17,400/yr/person
• Salary (Coal System) Direct and Indirect Cost (1982)	$23,600/yr/person
• Electricity - $22,000/mo first 6,000 kW $3.05/kW in excess of 6,000 kW/mo $0.041/kWhr	Full Purchase
$6.77/kW for all kW/mo $0.041/kWhr	Partial Purchase
• Low Sulfur No. 6 Oil	44.9¢/gal
• Low Sulfur Coal from Regional Utilities Board	$51.70/ton
• Potable Water	$0.80/1,000 gal.
• Annual Maintenance of Coal-Fired Boilers	2.5 of Initial Capital
• Annual Maintenance of dRDF Facility	$4/ton dRDF plus 5% of Initial Capital
• dRDF Delivery to University, Truck Cost	70¢/mi
• dRDF Residue Disposal	$6.75/Ton plus 70¢/mi
• Coal Delivery to University, Truck Cost	70¢/mi
• Boiler Ash Disposal	$3.25/ton plus $0.40/ton-mi
• Capital Costs Include 20% Contingency	
• Annual Capital Cost Determined by Assuming 6 1/2% - 20 yrs. plus 2.5% Underwriters Fee	

(a) in Cases II and III, it has been assumed that the University will pay an electrical demand charge of approximately 22,000 KW when, in fact, their demand may be much lower due to reliable use of their own turbine generators (it may be possible to lower the stated demand charge by approximately $600,000 per year); and (b) when comparing the relative economic benefits of Cases I, II, and III, it was assumed that O&M savings will escalate at 7 percent per year, when in fact composite escalation for all O&M costs may be closer to 8 percent due to the fact that O&M costs are dominated by the cost of energy. A higher escalation rate would tend to decrease the payback period and increase the present worth savings and interest rate of return.

Annual cost summaries for the existing utility system and the three alternative system configurations are shown in Tables 4 through 7. Table 4, the existing operation, indicates that the purchase of No. 6 fuel oil and electricity are the most influential cost factors and would tend to dramatically increase O&M costs in the future. The most realistic basis for comparison because future expansion would use coal is Case 2 , the Coal Reference System. From Table 5 it can be observed that there would be a continued use of purchased electrical power which would tend to significantly increase O&M costs in future years. Also, since Case I would consist of one new coal boiler and two existing oil/gas boilers, there is a need for excessive numbers of operators to staff both plants. This results in unnecessarily high salary costs.

Estimated O&M cost associated with the Coal Cogeneration System (Table 6) would be lower than O&M costs of the Coal Reference System since No. 6 fuel oil would not be required and there would be a lower demand for purchased electrical power (as a result of on-site power generation).

The annual O&M costs of the IUS are the lowest of all cases because of a reduced fossile fuel requirements resulting from coal being replaced by the firing of both low Btu gases generated from the University solid waste and densified refuse-derived fuel processed from Gainesville/ Alachua County solid waste.

A summary of the total capital and O&M costs and pertinent economic comparisons for Cases I, II, and III appears in Table 8.

Table 4

Existing University System

Operation and Maintenance (1982 basis)	$(1000)
No. 6 Fuel Oil 9,138,600 gal @ 44.9c/gal	$4,103
Purchased Power - 6000 kW @ $22,000/mo	264
22500 @ $3.05/kw-mo	824
137.5 x 10^6 @ $0.041 kWh	5,638
Personnel - 26 people @ $17,400/yr-person	452
Maintenance	130
Potable Water - 87,000 - 1,000 gal @ 80c/1,000 gal	70
Solid Waste Disposal	32
Total O&M	$11,513

Table 5
Case I. Coal Reference System

Capital (1981 Costs)	$ (1000)
1 - 120,000 lb/hr coal boiler	$19,521
2 - 1500 ton electrical chillers	900
Total Capital	$20,421
Annual Capita	$ 1,898

Operation and Maintenance (1982 basis)	$ (1000)
Coal 47,280 TPY @ $51.70/ton	$ 2,444
Low Sulfur No. 6 Fuel Oil - 1,827,800 @ 44.9¢/gal	821
Personnel - 26 @ $17,400/person	452
56 @ $23,600/person	1,227
Maintenance	637
Purchased Power - 6000 kW @ $22,000/mo.	264
22700 kW @ $3.05/kW-mo.	831
139.5 10^6kwh @ 0.041 kwh	5,720
Water	80
Ash Disposal - 5800 tons @ $3.25/ton	19
$0.40/ton/mi	14
Coal Delivery Trucking @ 70¢/mi	16
Solid Waste Disposal	32
Total O&M	$12,557

Table 6

Case F1. Coal Co-Generation System

Capital (1981 Costs)	$(1000)
2 - 150,000 lb/hr coal boilers	39,010
Absorption Chillers	1,250
Total Capital	$40,260
Annual Capital	$ 3,745
Operation and Maintenance (1982 basis)	**$(1000)**
Purchased Power - 22,000 kW @ $6.77/kW-mo	$ 1,787
- 13.1 x 10^6 kWh @ $0.041/kWh	537
Coal 114,700 tons @ $51.70/ton	5,930
Personnel 52 @ $23,600 1 person	1,227
Maintenance	1,006
Potable Water 101,000 - 1,000 gal @ 80¢/1,000 gal	81
Ash Disposal - 14,000 tons @ $3.25/ton	46
$0.40/ton-mi	36
Coal Delivery Trucking @ 70¢/mi	40
Solid Waste Disposal	32
Total O&M	$10,722

Table 7

Case III. Coal/Solid Waste Cogeneration System (IUS)

Capital (1981 Costs)	$(1000)
2 - 150,000 lb/hr coal boilers and absorption chillers	$40,260
1 - Off campus dRDF facility	7,300
1 - On-site solid waste gasifier	502
Total Capital	$48,062
Annual Capital	$ 4,471
Operation and Maintenance (1982 basis)*	**$(1000)**
Purchased Power - 22,100 kW @ $6.77/kW-mo	1,795
13.9 x 10^6 kWh @ $0.041/kWh	570
Coal 89,100 tons @ $51.70/ton	4,606
Personnel - 57 @ $23,600/person	1,345
Maintenance	1,084
Potable Water - 101,000 - 1,000 gal @ 80c/1,000 gal	81
Ash Disposal - 22,000 tons @ 3.25/ton	72
$0.40/ton-mi	57
Coal Delivery Trucking @ 70c/mi	31
Total O&M	$ 9,641

*O&M for off-campus dROF facility not included.

TABLE 8

FIRST YEAR ECONOMICS JULY 1982 – JULY 1983

(Thousands of Dollars)

	Existing System	Case I Coal Reference System	Case II Coal Cogeneration System	Case III Integrated Utility System
Operation and Maintenance Costs	$ 11,513	$ 12,557	$ 10,722	$ 9,641
Capital (July 1981)		$ 20,421	$ 40,260	$ 48,062
Incremental Capital versus Case I		---	$ 19,839	$ 27,641
Annual O&M Savings compared to Case I		---	$ 1,835	$ 2,916
Annual O&M Savings compared to Existing System		$ (1,044)	$ 791	$ 1,872
Present Value of O&M Savings compared to Case I[1]		---	$ 36,223	$ 57,562
Years to pay back capital in excess of Capital in Case I[2]		---	11 years	10 years
Interest rate of return[3]		---	13 %	15 %

1 Present value based on annual O&M savings escalated at 7% / year for 20 years and a discount rate of 6.5%.

2 Payback period based on annual O&M savings escalated at 7% / year and a discount rate of 6.5%.

3 Based on 20-year O&M savings escalated at 7% and the stated incremental capital requirement.

From Table 8 it becomes evident that complying with anticipated enforcement of Federal energy legislation by implementing a coal burning utility system will require a estimated minimum capital expenditure of $20,421,000. However, other coal-burning alternatives are available that would reduce the demand for scarce fuels and coal, while simultaneously reducing the University's utility operating budget. The question that must be answered is whether it makes more sense to select a low initial capital cost/relatively high O&M alternative (Coal Reference System) or a higher initial capital cost/lower O&M alternative (Coal Cogeneration System or the IUS). In general terms, it must be determined whether the incremental capital associated with Coal Cogeneration or the IUS, versus a Coal Reference System, can be justified by the anticipated O&M savings of the more capital-intensive utility systems.

The first economic factor calculated in evaluating the merits of increased capital spending was the present worth of twenty years of O&M savings. The present worth of O&M savings for the Coal Cogeneration and IUS systems are $36,223,000 and $57,562,000, respectively. Since these present worth values exceed the corresponding incremental capital costs by 16,384,000 and 29,921,000, it appears that the incremental capital is justified. The additional investment of $7,802,000 for adding the solid waste subsystems to the cogeneration subsystem results in $21,339,000 in additional present worth O&M savings.

The second economic indicator calculated was the payback period. The cumulative O&M savings of the Coal Cogeneration system would payback the incremental capital of $19,839,000 in 11 years. The O&M savings of the IUS would pay back the incremental capital of $27,641,000 in 10 years. Since the payback periods of both Cases II and III are significantly less than the 20 year useful life of the utility system, it can be concluded that the O&M savings of either system will more than compensate for the incremental capital to build either utility system.

The final economic factor evaluated in this analysis was the interest rate of return. In this analysis the rate of return can be viewed as being the interest rate that would result from investing the incremental capital for twenty years and receiving the annual O&M savings for the same period. In the case of the Coal Cogeneration System, investing the

incremental capital and receiving the estimated O&M savings would be equivalent to receiving an interest rate equal to 13 percent. The IUS interest rate is 15 percent. The magnitude of the two rates of return suggest either system is worthy of public investment.

The economic analysis indicates that the incremental capital necessary to construct either the Coal Cogeneration System or the IUS, compared to the Coal Reference System, would be justified based on the resultant O&M savings. However, since an economic basis cannot be solely used to determine whether to select either the Coal Cogeneration System or the IUS other factors must be considered. If factors such as conservation of nonreplenishable resources and reduced landfill requirements are significant; the IUS would be preferred over the Coal Cogeneration system.

An integral part of the IUS is the proposed off-site solid waste (dRDF) processing system. For this report, it has been assumed that the $7.3 million dRDF processing system would be financed with State funds. The dRDF system would be operated by the University in such a manner that the University and the State general fund would benefit from a decreased coal purchase requirement due to dRDF replacing a portion of the coal. The County would realize economic benefits in the form of a resource recovery system having a tipping fee (solid waste disposal charge) comparable to 1982 landfill costs, but with considerable reduction in the amount of land set-aside for solid waste disposal.

CHAPTER 3

IMPLEMENTATION CONSIDERATIONS

Implementation of the IUS would probably occur in four distinct phases:

- o Planning, System Selection, and Preliminary Design
- o Procurement
- o Final Design and Construction
- o Commercial Operations

The time estimated to complete each phase is shown in Figure 12, along with a representative profile of pre-operation cash outlays in 1981 dollars.

Planning, System Selection and Preliminary Design

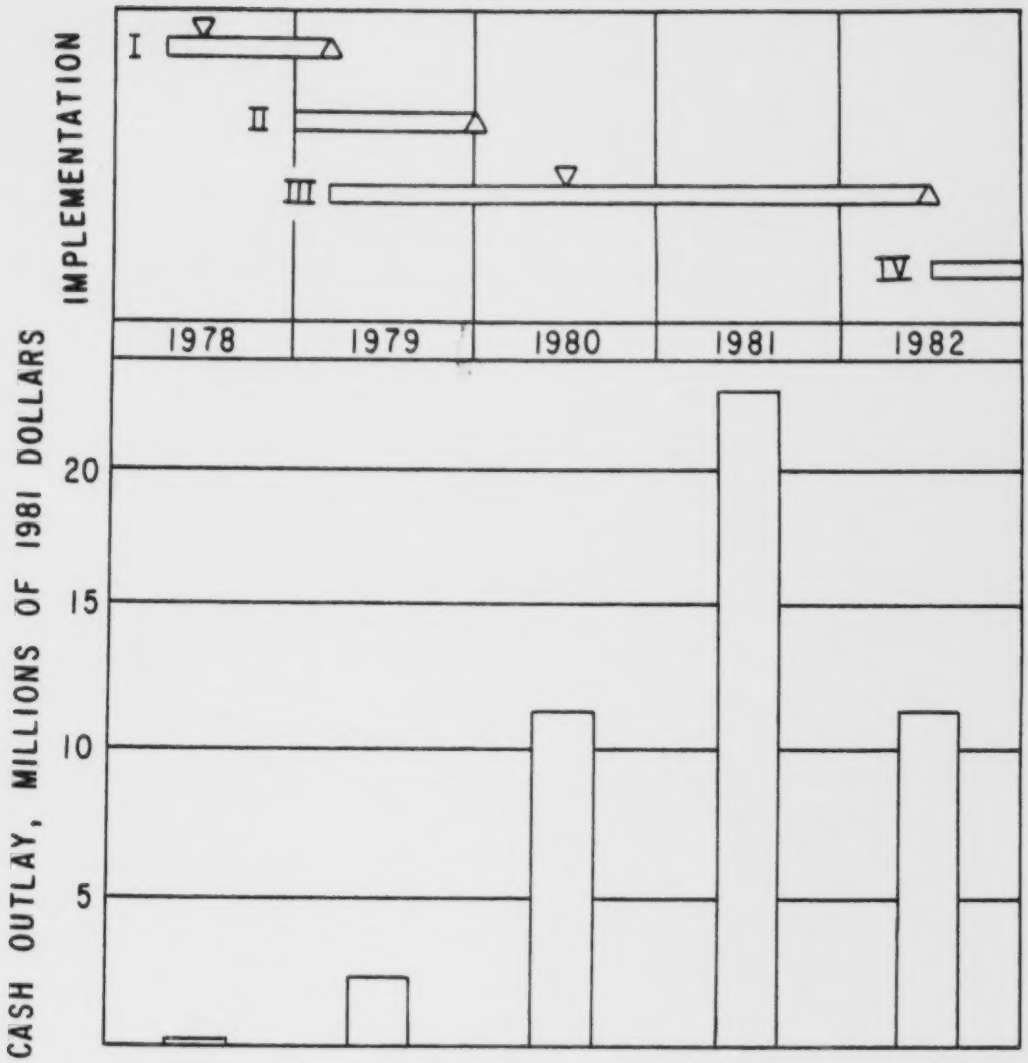
The initial phase of the project results in: (1) selection of the most appropriate design of the IUS, including the solid waste subsystem; (2) decisions on the risk postures of the participants in the project and on the best methods for procuring the facilities and equipment, for purchasing coal and electricity, and for securing the supply of solid waste; (3) decisions on organizational/institutional requirements and responsibilities for project implementation; and (4) definition of the legal and permit requirements which the project must meet. If the selected system includes processing County solid waste, the considerations associated with completing this phase of the project become more complex.

Of considerable importance to the project is the development of data and information for the project's decision-makers. Among the important information-producing tasks are:

a) An audit of the energy usage and costs at the University, including a detailed energy demand analysis by period and source. This information is particularly critical to the development of an optimal IUS with realistic equipment.

b) A survey of the Gainesville area solid waste, including location and quantities generated, composition, cost of collection and disposal, and degree of public control over the waste stream.

c) Definition of the likely terms and conditions for agreements to purchase the coal, deliver and dispose of solid waste, and purchase electricity. Although each of these elements is critical to a good understanding of the economic viability of the IUS, it is particularly important that the University



PHASE I: PLANNING, SYSTEM SELECTION & PRELIMINARY DESIGN

PHASE II: PROCUREMENT

PHASE III: FINAL DESIGN & CONSTRUCTION

PHASE IV: COMMERCIAL OPERATION

FIGURE 12

IMPLEMENTATION SCHEDULE AND CASH REQUIREMENTS FOR AN IUS AT THE UNIVERSITY OF FLORIDA

determine the structure of its rates for purchased electricity, including the demand charge.

d) Evaluation of alternative arrangements with municipalities in the Gainesville area for processing their solid waste and for their participation in the economic and environmental benefits of the resource recovery facility. Alternatives could range from a University-operated facility with a net disposal fee charged to the municipalities to a municipal or privately-operated facility with the University simply acting as a buyer of the fuel output.

e) Evaluation of alternative methods for procuring the cogeneration system and resource recovery plant. Alternatives could range from a full-service or turnkey contract for the entire system to an A&E approach with competitive bidding on the system components and trades. The evaluation of procurement approaches for the resource recovery facility should take advantage of experiences elsewhere in the country, especially as related to the transfer of technical and economic risks to the system designer and/or constructor. The ability to transfer project risks from the University to private industry is affected by the method chosen for procuring the system. Typically, there are three methods available (in ascending order of risk assumption by private industry):

- A&E is the customary architectural and engineering contract for facility design, preparation of competitive bid documents, construction management, and (sometimes) facility start-up. Construction and equipment installation are competitively bid.
- Turnkey involves a single entity, generally operating under a fixed price arrangement, who designs, constructs, and starts up the facility according to pre-determined performance specifications.
- Full-Service extends the turnkey arrangement into operations, generally with performance guarantees.

f) Evaluation of all local, state, and federal laws, regulations, guidelines, and permit requirements that might apply to the project. In addition to defining the legal environment within which the project must fit, this evaluation should identify any needs for special legislation or other legal action (e.g. legislation to allow the participating municipalities to achieve control over their solid waste).

g) Selection of a consultant and/or consulting engineer to perform a final feasibility analysis and to prepare a preliminary design of the IUS. Three important tasks for the consultant are to perform a detailed analysis of the University's present and future energy needs, assess final project economics, and to recommend an implementation strategy which conforms with the technical and economic realities of the project and the objectives and risk postures of the participants.

It is vitally important to the IUS project that an organization and individual be assigned the responsibility to manage the project and orchestrate the available resources. Equally important is a clear definition of the project decision-making process and the initiation of a process for involving the various project participants in the implementation process.

Procurement

The procurement phase of the project includes four major efforts:

a) The procurement of services and equipment to accomplish the design and installation of the IUS.

b) Negotiation of a contract with the Regional Utilities Board for the long-term supply of coal.

c) Negotiation of a contract with Florida Power Corporation for the purchase of electricity after the IUS is installed.

d) Negotiation of a contract (or contracts) with municipalities in the Gainesville/ Alachua County area for the disposal of their solid waste or, possibly, for University purchase of dRDF produced in a resource recovery facility which is operated by one of the municipalities.

The procurement of the IUS can be accomplished in several ways. The most desirable approach cannot be defined until more is known about the long-term objectives of the State and the University regarding responsibility for the risks of cost overruns, revenue shortfalls, and less than optimal system performance. Once this information is available, the University must first make a decision on who should operate the IUS, and for what period of time. This might involve evaluation of the tradeoffs between efficient operation of the system (which private industry might be expected to accomplish) and the annual operating and maintenance cost (which, if the system were privately operated, could be higher than public operation due to the addition of profits.)

Depending upon the method of system procurement, the process could include the following steps:

- Preparation and issuance of a request for proposals (RFP) (including possibly holding a bidder's conference) for the design and construction of the facility.
- Evaluation of bidder's proposals and selection of a preferred bidder.
- Authorization to enter into negotiations with the preferred bidder.
- Review, approval and execution of the contract by appropriate University and public officials and the contractor.

It may be appropriate to procure the two major subsystems of the IUS through different methods. For example, the cogeneration subsystem might be procured through an A&E approach, with the dRDF subsystem procured using a full-service approach.

Arrangements with the Regional Utilities Board require that the University secure agreements on three major issues: (1) the length of time that the RUB will commit to supplying the required amount and quality of coal; (2) the cost per ton of coal and mechanisms for adjusting the cost; and (3) modifications to the Deerhaven plant's coal receiving facilities. It can be anticipated that, although the RUB has been very cooperative, their negotiating position will be designed to protect their responsibility to their customers.

The installation of the IUS will require that the existing contract for purchasing electricity from Florida Power Corporation be modified. As mentioned earlier, the primary challenge is to develop a rate structure

which is reasonable, and especially to minimize the demand charge (which is estimated to be as high as $1.8 million). Reduction of the demand charge will require that the University prove that the cogeneration system will be reliable. As with negotiations with the RUB, Florida Power can be expected to be fair but not to take a posture which might threaten its ability to serve its other customers as efficiently as possible.

The relationship between the University, Gainesville, and possibly other municipalities in the area will be influenced by three major factors. First, their actions will need to conform the Alachua County's solid waste management plan, to requirements of the Florida Department of Environmental Regulation regarding solid waste planning and disposal, and to U. S. EPA requirements regarding solid waste disposal. Second, the structure of the relationship will depend on the municipalities perception of:

a) The reliability of the processing system;
b) The economics of the system; and
c) The ability of the University (or some other party representing the University) to operate the system.

Third, the economics and positive energy consequences of the IUS depend significantly on the availability of dRDF for the cogeneration system. This means that both the University and the State will want to be satisfied that, on a long-term basis, the dRDF plant is operated efficiently, that sufficient amounts of waste are delivered to the plant for processing, and that appropriate disposal fees are paid by those who deliver the waste.

These factors may lead toward several alternative contractural arrangements between the University and the municipalities. Two of these alternatives are:

a) University Operations (or contract for operations)
    1) The municipalities pay a net disposal fee equal to annual O&M minus the magnetics revenues and some share of the plant's energy product yield.
    2) The municipalities agree to deliver, or cause to be delivered, minimum amounts of waste over a long-term period (e.g. 20 years) and to pay the disposal fee.

3) The University agrees to accept and process the guaranteed minimum amounts of waste at a reasonable cost.
4) The University purchases the dRDF for a low price (e.g. 10 to 30 percent of its "value").

b) Municipal Operations (or contract for operations)
1) The municipality agrees to deliver minimum amounts of dRDF of a specified quality to the University.
2) The University agrees to pay for the dRDF on par with the price it is paying for coal, minus some discount (e.g. 10 to 30 percent).

Implementation of the full IUS requires the development of information on the desires of both the University and the municipalities so that all parties can agree on the best basis for a contractual relationship.

Final Design and Construction

During this phase of the project, the University will need to accomplish several tasks to assure that the project is successfully implemented. The first task is to assure that design and construction of all subsystems is scheduled properly and that schedule adjustments during construction do not result in, for example, dRDF being available before the boiler is installed and through shake-down. The second task is to ascertain that contractors have met their design or performance specifications and that change orders, claims of Force Majeure and the like are rigorously managed. Both of these tasks may require that the University engage a consulting engineer to monitor the entire design/construction process. The third major task is to secure all of the permits necessary to start construction and begin operations. Appendix D contains a compendium of the State of Florida permits necessary to implement an IUS at the University of Florida.

APPENDIX A

DESCRIPTION OF THE EXISTING UNIVERSITY UTILITY SYSTEM

Electricity

A 1,000 kW backpressure turbine/generator at Heating Plant No. 2 generates approximately 5% of the total electricity consumed by the University. The remaining electricity is purchased from Florida Power Corporation, which supplies the power through two 69/23 kVA transformers at its substation on campus. The substation is located near Heating Plant No. 2 in the southwest section of the campus. Power distribution from the substation to campus distribution vaults is at 23 kV. This voltage is transformed to 4 kV at the vaults and then fed into the campus grid system.

The University has minimum on-site emergency operating capability. When the medical center was constructed in 1956, an emergency power supply was installed. Since that time, the facility has tripled in size with no increase in generating capacity. The system was designed to provide power for operating rooms, hall lights, and two elevators. There is no emergency power for air conditioning, even in the operating rooms. The University has no other substantial emergency generating capacity.

The existing contract between the University and Florida Power Corporation provides for on-site power generation in parallel with purchased power.

Steam

Steam was originally generated at Heating Plant No. 1, but due to equipment age and economic considerations, the steam generating facilities have been retired. All steam is now generated at Heating Plant No. 2 and Heating Plant No. 1 is now used as a pressure reducing station and steam distribution center, and for condensate collection from the older section of the campus.

Heating Plant No. 2 was placed in operation in 1957 and initially served an isolated steam distribution system. Low pressure interconnections were later made allowing limited interchange between Heating Plant No. 2 and Heating Plant No. 1.

A 12-inch, 250 psig steam header was installed to interconnect the two plants in 1967. The plant, whose steam generating equipment is listed in

Table A1, now generates all the steam used on campus.

With the addition of Boiler No. 5, Boilers 1 and 2 have been placed in reserve service, and therefore, the normally available operating capacity is 290,000 lbs/hr.

Steam from Heating Plant No. 2 is supplied to Heating Plant No. 1 at 250 psig pressure. At Heating Plant No. 1, the pressure is reduced to 60 psig and then distributed to the campus. The 1,000 kW steam turbine at Heating Plant No. 2 exhausts into the distribution system at 60 psig. The distribution system includes approximately 20 miles of underground steam and condensate lines. At the buildings, the pressure is reduced to 15 psig and passed through heat exchangers to produce low temperature hot water for intra-building space heating. The central heating plant is estimated to service 7.6 million square feet of space. Some interconnection and looping of the 60 psig distribution system has been installed.

The condensate from most of the northern part of some of the north-eastern part of the campus drains to collecting tanks inside Heating Plant No. 1. This condensate is pumped to a storage tank and then flows by gravity to Heating Plant No. 2.

Chilled Water

Since 1956, the University has been incorporating air conditioning into new classrooms and office buildings. Conversion of older buildings began in 1958 and is continuing. Based on a central air conditioning feasibility study, the University is expanding the central chilled water generation capacity to approximately 16,000 tons. This capacity will provide for both replacement of dispersed electric driven equipment and the addition of new building loads. Present and future chiller capacity is summarized in Table A2.

Existing central chillers are located at Heating Plant No. 2 and the Walker Hall Chiller Plant. The distribution system is an underground, two pipe system originally designed to afford sufficient pressure to provide chilled water flow inside connected buildings without building pumps. However, at least two buildings connected to the existing system have building pumps installed as a result of problems experienced within the distribution loop. Future chillers are planned to be located at Heating Plant No. 1 and additional chilled water lines are to be installed as the centralization of the chiller capacity takes place and the refrigeration machines are installed.

Table A-1

Existing Steam Generating Facilities

Heating Plant No. 2

Boiler No.	Year Installed	Operating Pressure, psig	Steam Temperature, °F	Boiler Capacity, lbs/hr	Fuel
1	1957	250	500	60,000	oil/gas
2	1957	250	500	60,000	oil/gas
3	1967	250	500	120,000	oil/gas
4	1973	250	500	50,000	oil/gas
5	1977	250	500	120,000	oil/gas

Table A-2

Present Central Chilling Capacity

Year Installed	Location	Type	Capacity, Tons			
			Electric	Steam Turbine	Absorption	System Cumulative
1956	Walker Hall	Electric	400			
		Centrifugal	400			800
1957	Plant 2	Steam Turbine				
		Centrifugal		2,400		3,200
1970	Plant 2	Steam Turbine		1,750		
		Centrifugal		1,750		6,700
1977	Walker Hall	Electric	1,000			
		Centrifugal				
1977	Plant 2	Electric	1,200[1]			
		Centrifugal	1,200[1]			
1979[2]	Plant 1	Electric	1,450			
		Centrifugal	1,450			13,000
1982[2]	Plant 1	3				16,000

[1]Replaced 3 - 700 ton steam jet units

[2]Total capacity added after 1977 is based on approximately 1,000 tons new load and 4,900 tons which replaces dispersed electric-driven unitary equipment.

[3]The University has planned for the addition of 3,000 tons which will increase total central chilling capacity to 16,000 tons.

Potable Water

The City of Gainesville presently provides all potable water to the University. The University distributes the water to all on-campus buildings and maintains its own distribution system. The distribution system consists of several thousands feet of 6- to 12-inch mains with average pressure in the system ranging from 50 to 80 psi, depending on elevation.

Solid Waste Disposal

Currently, University solid waste is collected and hauled directly to the landfill site by means of compaction trucks or is collected, compacted in a transfer station, and then transported to the landfill. In 1977, the University waste exclusive of vegetation was estimated at 7,000 tons. The sanitary landfill is under the jurisdiction of Alachua County. The University attempts, wherever possible, to separately collect aluminum cans for recycling. Leaves and bushes are collected, stored, and burned in an open pit.

APPENDIX B

SUMMARY OF OPERATING AND MAINTENANCE COSTS
FOR THE EXISTING UNIVERSITY UTILITY SYSTEM

Utility Rates

In the spring of 1978, the University was paying for fuel and utility services as follows:

a. Electricity — Demand Charges:
$15,184 for the first 6,000 kW/month
$2.09/kW for demand in excess of 6,000 kW/month

Basis:
Not less than 70% of the highest demand during the preceding 12 months

Energy Charges:
$0.0284/kWh

Fuel Adjustment:
Less $0.004 per kwh when FPC nuclear plant operating
Add $0.002 per kwh when FPC nuclear plant not operating

Minimum Monthly Billing:
Not less than $2.53/kW of highest demand established during preceding 12-month period

b. Fuel Oil — The University's latest purchase of oil in 1977 was:
No. 6, $0.30/gal

c. Natural Gas — $0.13597/therm ($10^5$ Btu), based on December, 1977 billing. This represents a 14.4% unit cost increase during 1977.

d. Potable Water — $0.60/1,000 gal.

e. Solid Waste Disposal Tipping Fee — $0.75/cu.yd.

Operation and Maintenance Costs

Total operating and maintenance costs for the existing University utility system in 1977 is summarized as follows:

	Cost, $1000
Purchased Power	$ 4,169
Natural Gas	1,276
Fuel Oil	501
Personnel (including indirects)	345
Boiler Maintenance	80**
Water	52*
Solid Waste Tipping Fee	24*
TOTAL	$ 6,447

* Estimated
** Primarily service contracts

APPENDIX C

HISTORICAL AND PROJECTED TECHNICAL DATA

Population

Historical and projected population for Alachua County as well as for subset communities within the county is shown in Fig C1.

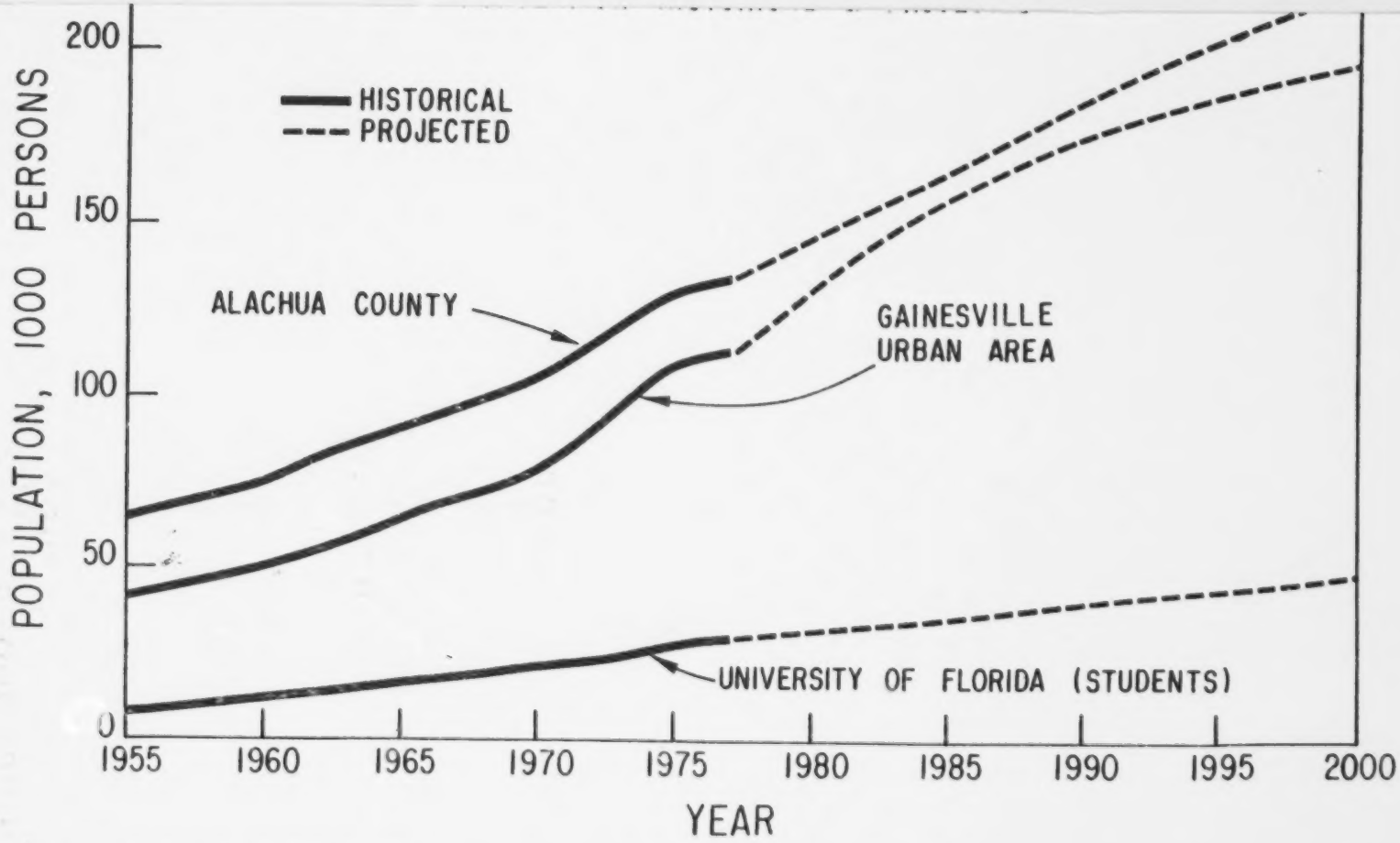
Since 1960, the University population has increased at an average compound growth rate of 5%/year to the present 30,000 students. Future enrollment is projected to the year 2000 at a growth rate which is declining from 2.5%/yr. in the near future to 1.7%/yr. toward the year 2000.

The most significant population growth is expected to occur within the immediate area around the City of Gainesville. A sharp upward trend started in 1970 and is expected to continue through the 1980's with a leveling trend in the 1990s. Thus, population in the Gainesville urban area is expected to increase by a factor of 1.77 by the year 2000.

Population in the balance of the county is expected to remain relatively stable through the year 2000, and the Gainesville urban area population, which is currently 85% of the county population, will increase to approximately 90% in the year 2000.

Steam

Steam requirements have been increasing with University growth and expansion. Historical and projected steam demand and consumption is shown in Fig. C2. In the period from 1960 to 1969, steam consumption rose at an average compound rate of 5.5%/year; whereas, from 1969 to the present, the rate of increase reflects an average 1.0% growth. This leveling of growth rate is attributed to both a reduced rate of University growth and implementation of energy conservation measures.



*"ALACHUA COUNTY COMPREHENSIVE PLAN – 1975–1995," NORTH CENTRAL FLORIDA REGIONAL PLANNING COUNCIL, DEC. 1975, AND "ECONOMIC INDICATOR, GAINESVILLE/ALACHUA COUNTY" ALACHUA CO. DEPARTMENT OF PLANNING AND DEVELOPMENT, 1978.

FIGURE C1

PROJECTED AND HISTORICAL

POPULATION FOR THE GAINSVILLE URBAN AREA

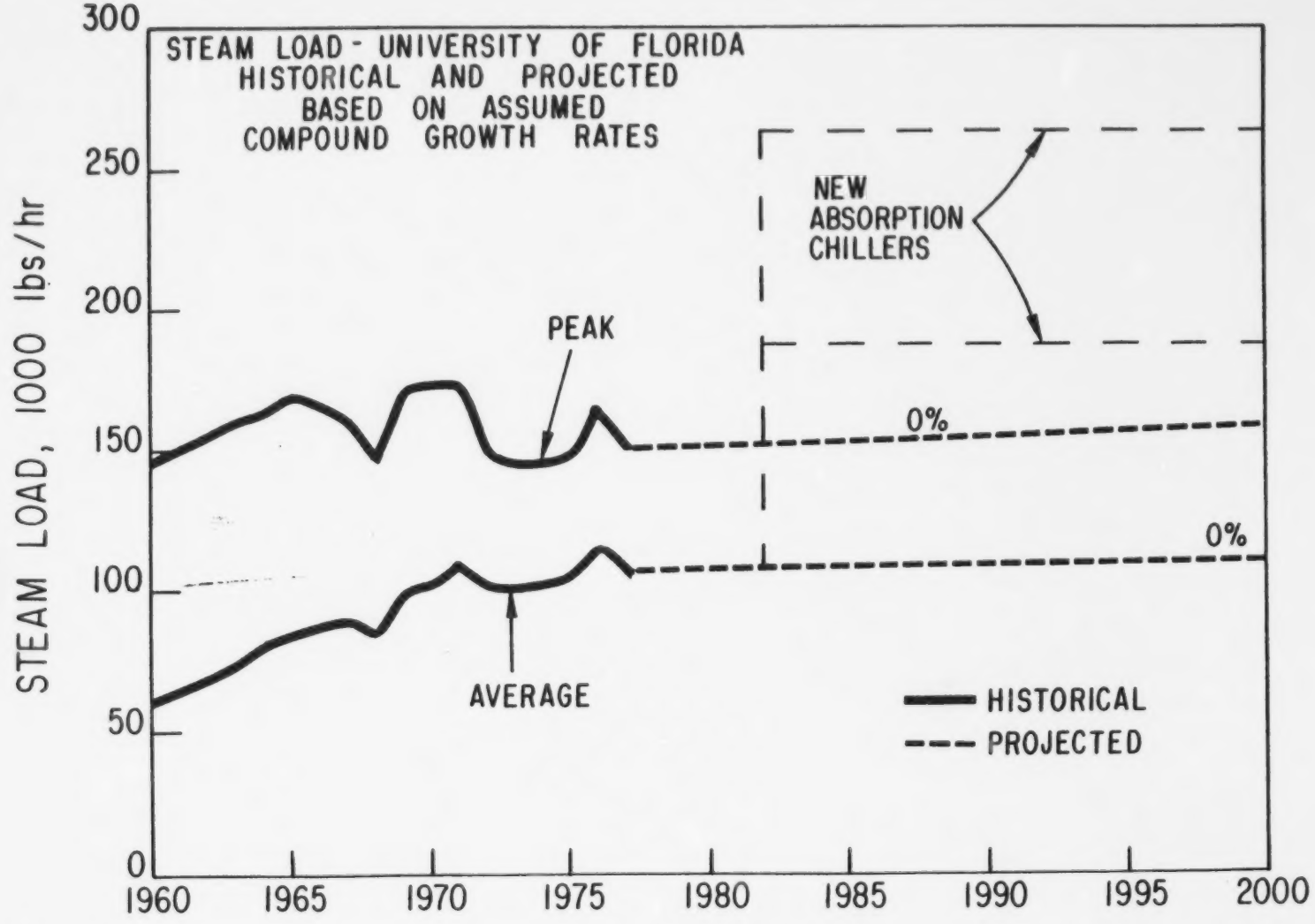


FIGURE C2

HISTORICAL STEAM LOAD AND FUTURE GENERATION CONSIDERING BOTH NO DEMAND INCREASES AND THE NEW ABSORPTION CHILLERS

Based on recent trends, the renovation of existing facilities to more energy efficient systems, and the replacement of older buildings and/or addition of new buildings with more energy-conserving design, the growth rate is expected to be between 0 and 2% with the lower value being more probable. Therefore, for the analysis presented in this report, projected steam requirements for the existing University system are based on the assumed zero growth rate.

For the IUS system analyzed, a greater portion of the University's chilled water requirements will be produced by the utilization of low pressure steam driven absorption units. Thus the projected load results in a stepwise increase in 1982 with zero growth assumed thereafter as for the existing system.

The ratio of peak steam consumption to average load has decreased from 2.35 in 1960 to 1.40 in 1977. This reduction in peak demand is attributed to a better diversity of steam-using equipment and the introduction of more steam-driven chilling equipment. The ratio of peak to average steam demand has leveled in the last few years and little further improvement is anticipated. Therefore, projected peak steam demand is assumed to continue at the current ratio of 1.4 to average load.

Electricity

Historical and projected electrical loads for the University are shown in Fig C3. In the 11-year period since 1966, electrical consumption increased at an overall average compound rate of 8.5%/year. However, most of this increase occurred between 1966 and 1971 at a 15%/year rate, and the average rate of increase has only been 2%/year for the six year period subsequent to 1971.

During the early 1970's there was actually a decline in load which is attributed to conservation measures; and since 1975 the load has increased. This recent increase is attributed primarily to operation of two new 1,200 ton electrically-driven chillers in 1977.

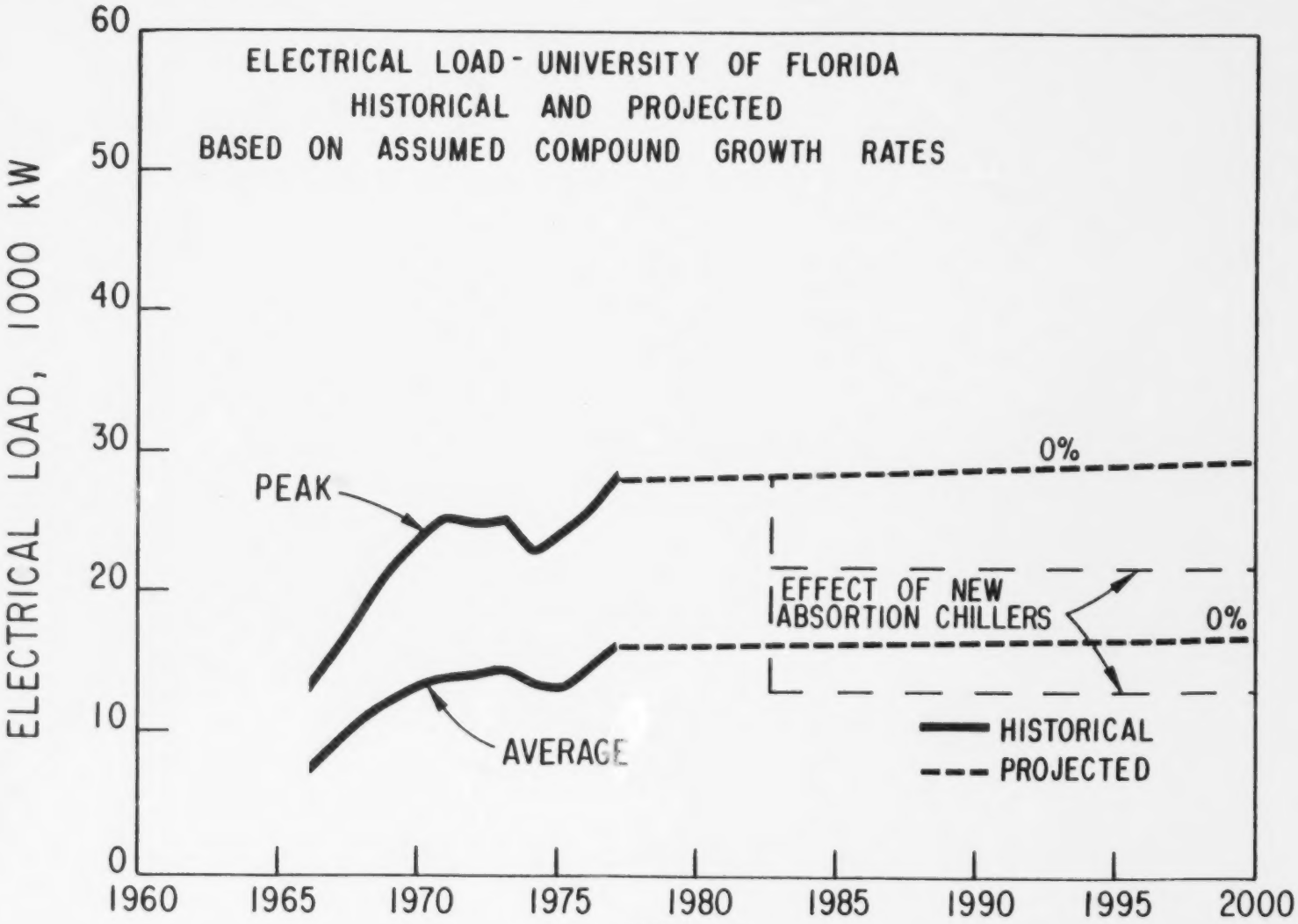


FIGURE C3

ELECTRICAL LOAD PROFILES CONSIDERING BOTH NO LOAD GROWTH
AND THE ADDITION OF ABSORPTION CHILLERS

As for steam consumption, the projected electrical requirements for the existing University system are based on an assumed zero growth rate. Similarly, the use of absorption chillers with the conceptual IUS for producing a greater percentage of the cooling requirements will reduce the dependency on electric driven cooling equipment by an equivalent amount. Thus the projected load results in a stepwise increase in 1982 with zero growth assumed thereafter.

Peak electrical demand has averaged 1.75 times the average load since 1960. This ratio of peak to average demand is assumed to remain the same in the future.

Energy Requirements for the Conceptual IUS.

As discussed in Chapter 2, the basis of the conceptual IUS is to maximize the University's ability to self-satisfy all of its energy requirements without becoming an exported of electrical grower. Accordingly, the production of electrical power and the ability to utilize the resultant low pressure steam must be balanced. Utilizing University electrical consumption for 1977 as a basis, the data was adjusted for the equivalent power that would be saved by producing up to approximately 50% of the chilled water requirements with steam driven absorption units. This modified electrical load is shown in Figure C4 and indicates both seasonal variation and approximate daily variations. It should be noted that the average load is approaching an idealized level demand. This curve shows less seasonal variation than orginal 1977 data. Further, due to the ability to generate up to 15,000 kw, and decrease chilled water production with the load managing regeneration heater, it is possible to follow daily load variations in order to support the yearly average load used in the technical analysis.

The decrease in average load compared to the existing system is reflected by a stepwise decrease of electrical load shown in Figure C3. Likewise, there is a corresponding stepwise increase in steam to account for the absorption chiller steam consumption as shown in Figure C2.

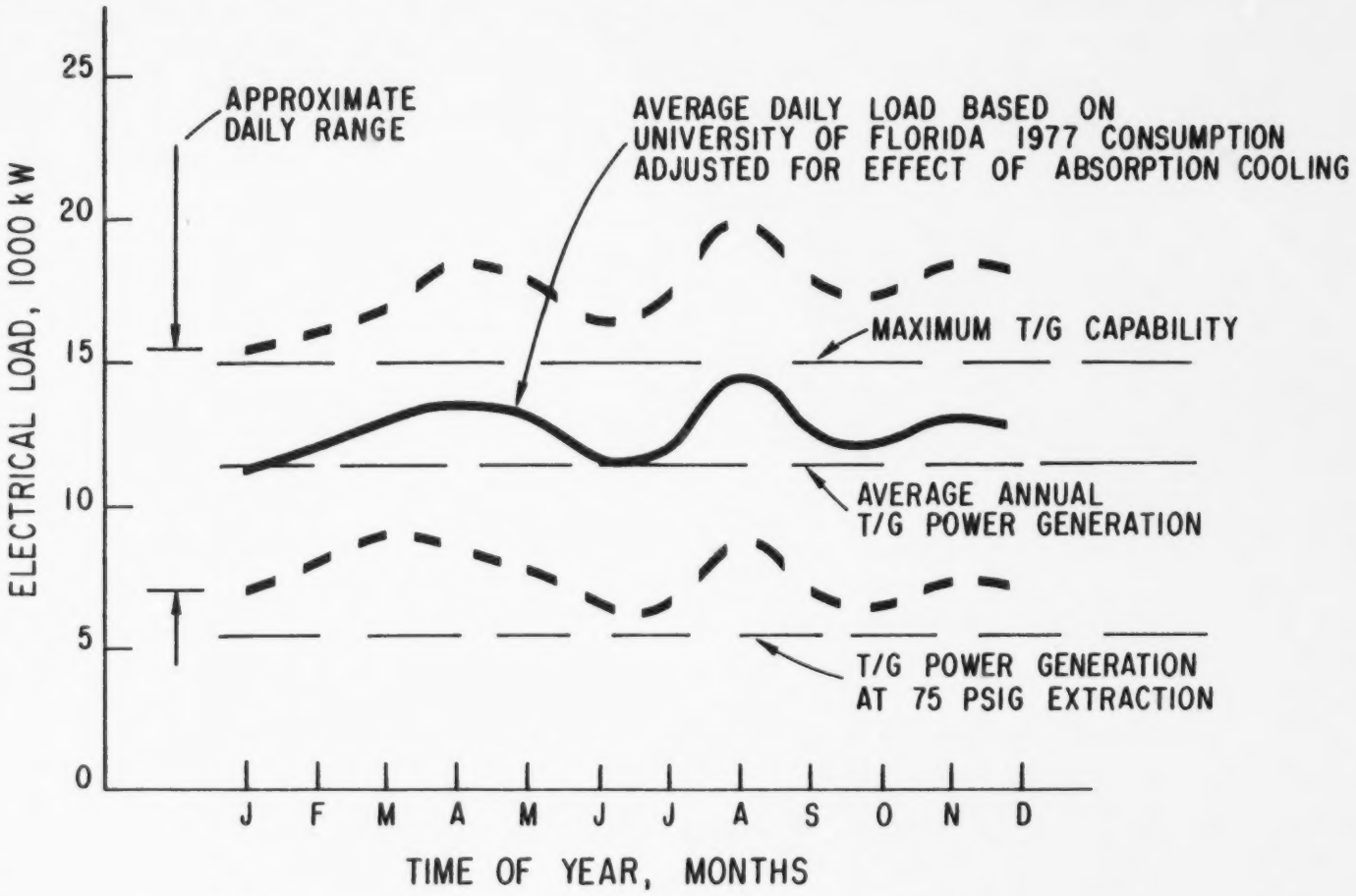


FIGURE C4
CALCULATED UNIVERSITY OF FLORIDA
AVERAGE MONTHLY ELECTRICAL
REQUIREMENTS CONSIDERING
THE IMPACTS OF AN IUS

APPENDIX D

NECESSARY STATE PERMITS FOR AN IUS AT
UNIVERSITY OF FLORIDA

In order to protect the public from an action which could have a net adverse environmental impact, nothing can be built in Florida without first showing that all reasonable steps have been taken to mitigate against such an occurrence. In order to protect the public and assure a comprehensive assessment of a proposed action, the Florida Statutes provide that "no stationary installation which will reasonably be expected to be a source of air or water pollution shall be operated, maintained, constructed...without an appropriate and currently valid permit issued by the Department of Environmental Regulations."

Mechanically, the rules of the Department of Environmental Regulations require two general types of permits. The construction permit is the legal authorization to construct, expand, modify or make alterations to any installation; however, only temporary operation and testing is permitted under this permit. The operation permit is the legal authorization to operate or maintain the installation for a specified period of time, after which they may be renewed.

The mechanics of obtaining these permits are functionally the preparation of an Environmental Impact Assessment. This assessment must be comprehensive to obtain the necessary Solid Waste, Air Pollution, NPDES, Water Pollution and Sewage Works permits. Because the University will not be generating power for sale, the Florida Electric Power Plant Siting Act would probably not apply. The steps required to obtain the needed construction and operating permits are synopsized in the following discussion.

Construction/Operation of Solid Waste Resource Recovery and Management System. Although both permits are required, a single application form properly completed will suffice provided that no design or operation criteria are changed following submission of the construction permit application. The operation permit will be issued upon submission of a copy of the construction application signed by the applicant and a

registered professional engineer. Only a single construction permit is required for the transfer/processing station located in the Gainesville area, transportation facilities for the recovered fuel to the University, and gasification of the University waste on site.

The rules of the DER provide that "the Department shall plan for and regulate the storage, collection, transport, separation, processing, recycling and disposal of solid waste..." "Recycling" is defined as including power production. Permits are required for resource recovery management facilities. In addition to maps and drawings, the application must include a process description, including type and volume of materials processed; provision for disposal of residuals; type of materials recovered and disposition of same; process water and treatment after use, management and maintenance procedures, energy recovery, and all information relevant to the method of operation.

Construction/Operation of an Air Pollution Source. Two separate permits, one for construction and one for operation, are required. Under new DER regulations which were promulgated April, 1978, the application for a construction permit now consists of two steps to conform to the state's anti-degradation policy. Applicants must now show that they will meet standards for both local increments of degradation as well as state-wide standards. Dispersion modeling is required, with particular attention paid to ambient SO_2 and particulate increases. A separate reporting form must be completed, setting forth evidence that Best Available Control Technology has been planned. This form is considered for up to 90 days. Following approval of the basic siting application, a construction permit application must be submitted for consideration requiring up to an additional 90 days. This application includes an engineer's report encompassing plant description, operations, types and quantities of waste materials generated, treatment methods and design criteria (based on lab or pilot plant studies, if warranted), design efficiencies, types of secondary pollutants in treated effluents or emissions. An owners' written guarantee to meet design criteria and rules and regulations of DER is also included and a compliance bond may be required.

Operating Permits (New Sources) will be provided after review of satisfactory:

1) Test results from trial runs;
2) Certification of construction completion by permittee or his engineer; and
3) Final construction costs of pollution control facilities.

NPDES Permit. At present, the University is treating its wastewater in its one treatment plant. Wastewater from the conceptual power plant will have to undergo pretreatment, and then treatment in the University's plant, with ultimate discharge into Lake Alice. The University will have to apply for a new NPDES permit, based on a change of inputs. This application must be made directly to the Regional Administrator, Region IV, Atlanta. "Any applicant (for a NPDES permit) shall provide the... permitting agency a certification from the State...that any such discharge will comply with the applicable provisions of §301, 302, 306, and 307 of the Act." However, if the certifying agency, in this case the DER, fails or refuses to act on a request for certification within a reasonable period of time (generally 3 months), the certification shall set forth any effluent limitations and other limitations, and monitoring requirements necessary to insure compliance with any effluent limitations and other limitations under §301 or 302 of the Act, standard of performance under §306...or,..pretreatment standard." The DER has certification forms, which are distinct from the requirements for an Operations Permit for Water Pollution Sources. The sections of the Federal Clean Water Act which are subject to certification are: effluent limitations, national standards, and toxics and pretreatment standards. DER may take up to 100 days to issue the certification.

Operation Permit for Water Pollution Sources. This permit is issued by the Department of Environmental Regulation. As in the case of NPDES permits, the University will have to apply for a new permit, because the contaminants will be changed in type, concentration and other factors.

The application will have to specify:

1) The daily concentration and total daily weight of each contaminant contained in the discharge;

2) The daily temperature of the discharge;
3) Any additional information reasonably necessary to evaluate the effect of such discharges upon the receiving waters.

Permits Required for Sewage Works. The University's sewage collection system and sewage treatment plant will not undergo any modification, according to present plans, and therefore it ought not to be necessary to obtain a Sewage Works Permit. A formal letter should be sent to DER requesting confirmation.